Why Not Tax It? The Effects of Property Taxes on House Price and Homeownership

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Abstract

How do property taxes affect house prices, homeownership, and welfare? This study focuses on Italy, a country with high homeownership, an outdated property tax system, and unsuccessful reform attempts. In Italy, owner-occupied houses are exempt from property taxes, and property taxes are based on outdated cadastral values, which increase the regressivity of the tax system. Specifically, cadastral values capture a smaller percentage of market value for more expensive properties. I develop a life-cycle model with endogenous homeownership to evaluate the effects of reforming the current system. My findings reveal that removing the owner-occupied exemption and updating cadastral values to reflect market values increases property tax revenues as a percentage of GDP by over 0.8 percentage points and raises homeownership rates by 2.6 percentage points. This increase in homeownership is driven by lower property tax rates on smaller houses. Finally, I show that this policy improves the welfare of new generations in the long run, primarily due to a decrease in house prices in equilibrium. However, in the short run, the welfare of older households decreases.

Keywords: Property Taxes and Assessment, Housing Markets, Homeownership, Wealth Accumulation and Bequests

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1 Introduction

Taxation of wealth is being proposed as a tool to generate government revenue for rising public expenditure and potentially address the growing inequality. Since housing constitutes a significant portion of wealth, and its value relative to national income has been increasing over the past 70 years, the taxation of land and property has received significant attention in public debates across several countries (Borri and Reichlin, 2021, Bonnet et al., 2021).

However, because housing is more evenly distributed than other forms of wealth and provides essential consumption services, property taxation has become a source of political tension. For these reasons, many countries exempt owner-occupied houses from property taxes. Additionally, the housing values used for taxation, known as cadastral values, often do not reflect market values. Together, these can generate a progressive or regressive property tax system.

How do owner-occupied exemptions and the progressivity of property taxes affect house prices, home ownership, and welfare? I address this question by focusing on Italy, where the homeownership rate is high, and real estate wealth constitutes a large share of household wealth (Liberati and Loberto, 2019). Furthermore, Italian cadastral values significantly under-report the market value of properties, particularly for higher-value homes, which increases the regressivity of the property tax system (Guerrieri, 2013, OECD, 2021).[1]

This paper quantitatively analyzes the effects of a property tax reform that eliminates the owner-occupied exemption and transitions from a regressive to a proportional property tax schedule. The tax schedule switch is implemented by adjusting cadastral values to align with market property values. The analysis focuses on the reform's impact on homeownership patterns, property tax revenues, and welfare outcomes.

To conduct this analysis, I develop a dynamic equilibrium model calibrated to reflect key characteristics of the Italian housing market, including homeownership rates and household wealth. The model accurately captures several non-targeted aspects of the Italian housing market, such as the life-cycle dynamics of homeownership and wealth,

[1]For further details on these reforms, see Cencig (2012), Messina and Savegnago (2015), Agostini and Natali (2016), Di Porto et al. (2021) and Appendices A and C

and homeownership rate along the income and wealth distribution.

In the model, households go through a stochastic life cycle with uninsurable income risk, making decisions about consumption, savings, and housing services. They can choose to obtain housing services either by owning or renting a home, with prices determined in equilibrium. Households also have a bequest motive, with bequests distributed to younger generations. The probability and value of these bequests depend on the household's current income, reflecting existing inequalities in transfers. A construction firm supplies housing units using a technology with diminishing returns to scale. Finally, the government taxes household income and properties.

The model incorporates the discrepancy between market and cadastral property values, which I document using a municipal-level dataset I constructed. The analysis shows that cadastral values are, on average, lower than market values, with more valuable houses tending to have relatively lower cadastral values. This means that the percentage of market value captured by the taxable value decreases for more expensive properties, resulting in a lower effective property tax rate for these properties. I incorporate these findings into the model by implementing an estimated regressive effective property tax function.

I use the simulated economy to conduct several tax revenue-neutral counterfactual scenarios. Tax revenue neutrality is maintained by adjusting labor income taxes to offset changes in property tax revenue. In the first counterfactual, I remove only the owner-occupied exemption, meaning homeowners pay property taxes on their primary residence. Building on this, I introduce a second counterfactual that not only removes the owner-occupied exemption but also transitions from the estimated regressive effective property tax system to a proportional one. This policy involves adjusting cadastral values to match market values and applying a uniform tax rate across all properties. I refer to this scenario as the Flat Tax reform. These two counterfactuals reflect property tax system reforms previously attempted in Italy.

Additionally, I use the model to explore alternative property taxation systems. Specifically, I examine the effects of modifying the Flat Tax reform by either netting property taxes against the mortgage value or implementing a progressive tax rate. The first alternative implies that homeowners with an outstanding mortgage—typically younger households—pay lower property taxes than those without a mortgage, even for identical houses. The second alternative introduces a progressive tax rate, reducing the property tax burden on smaller houses and thereby encouraging their purchase.

I find that the government can significantly increase tax revenues from properties by fully removing the owner-occupied exemption. Property tax revenues collected from households as a percentage of GDP increase by 0.89 percentage points. However, this policy alone leads to a 2.6 percentage point drop in homeownership and a 2 percent decline in house prices.

When this policy is complemented by adjusting cadastral values—implementing the Flat Tax reform—the homeownership rate increases by 2.6 percentage points compared to the benchmark. At the same time, property tax revenue as a percentage of GDP increases by 0.87 percentage points, slightly less than in the first scenario. This suggests that the government can simultaneously boost property tax revenue and homeownership. The rise in both is driven by a 4.4 percent decrease in house prices. By adjusting cadastral values, the effective property tax rate decreases for cheaper houses and increases for more expensive ones, reducing overall demand for housing units, lowering prices, and encouraging the purchase of smaller homes.

The alternative taxation systems add little to the Flat Tax reform. When taxing properties net of mortgages, house prices drop similarly, but homeownership increases further. The share of owners with an outstanding mortgage rises by 1 percentage point compared to the benchmark and 1.5 percentage points compared to the Flat Tax scenario. Under progressive taxation, homeownership rises even more, especially among households in the bottom deciles of wealth and income, leading to a 1 percentage point reduction in the wealth distribution Gini coefficient. However, house prices drop by around 10 percent, and property tax revenues do not increase as much as in the other scenarios, depending on the progressivity of the tax schedule.

Finally, I compare the short-run and long-run welfare impacts of each counterfactual policy. In the long run, welfare, measured as the consumption change needed to keep individuals indifferent between steady states, improves in all scenarios. The overall welfare gain is 2.8% when all properties are taxed with a proportional property tax. This increase in welfare, despite higher property taxes, can be attributed to lower income taxes and the general equilibrium drop in house prices. Conversely, the short-run analysis shows that the welfare of households alive at the time of the reform drops by 3% on average, with significant variation across age groups. Young households benefit, while older ones lose, highlighting the political tension inherent in property tax reforms (Li and Lin, 2023).

Literature. This work is closely linked to three strands of the literature: macroeconomic housing models, the distributional characteristics of property tax schedules, and the analysis of tax reforms in Italy. My model builds on several studies that have developed housing models with endogenous house prices to assess the effects of housing-related taxes, including those by Chambers et al. (2009) and Kaas et al. (2020).

An important finding in this literature is that reducing the preferential tax treatment of housing increases welfare. For instance, Gervais (2002) demonstrates that welfare would improve if imputed rents were taxed or if mortgage interest payments were not deductible. Similarly, Sommer and Sullivan (2018) find that removing the mortgage payment deduction would lead to welfare gains and argue that homeownership rates would not decline. Finally, Floetotto et al. (2016) show that while removing the asymmetric tax treatment of owner-occupied housing improves welfare across steady states for most agents, this benefit is not uniform during the transition, as some agents experience welfare losses.

The second strand of the literature examines the progressivity or regressivity of the property tax system, highlighting three key aspects. First, housing is subject to numerous taxes and policies, making it challenging to characterize the system's distributional aspects. For example, owner-occupied and homestead exemptions increase the progressivity of the property tax system, while mortgage interest deductions or exemptions from capital gains can decrease it (McMillen and Singh, 2020, Matsaganis and Flevotomou, 2007, OECD, 2022). Second, the overall distributional effects of the property tax system depend on the economy's homeownership structure. A progressive property tax system yields different outcomes if homeownership is concentrated at the top of the distribution or spread throughout it (Bises and Scialà, 2014).

Third, the progressivity of the property tax system depends on the accuracy of cadastral values. Cadastral values that systematically misreport some house values can alter the system, making it more or less progressive, or even regressive (Paglin and Fogarty, 1972, McMillen and Singh, 2020, Avenancio-León and Howard, 2022). A stylized fact in this literature is that the assessment ratio—i.e., the ratio of cadastral value to market value—tends to be higher for low-value properties. This implies that less valuable houses have cadastral values that capture a larger percentage of their actual market value, increasing the system's regressivity.

Finally, my work relates to several papers that analyze property tax reforms in Italy. Cammeraat and Crivelli (2020) use microsimulation to evaluate the redistributive effects of a tax revenue-neutral reform that shifts taxation from income to housing wealth and consumption in the Italian context, finding that it would create a more progressive tax system. Unlike a microsimulation, however, my model accounts for behavioral and second-round effects.

Furthermore, Liberati and Loberto (2019) and Oliviero and Scognamiglio (2019) evaluate the effects of the 2012 Italian property tax reform, which increased cadastral values and temporarily removed the owner-occupied exemption. The former employs a search and matching model, while the latter conducts an empirical causal analysis at the municipal level. Both studies, consistent with my findings, report that the reform led to a decrease in house prices. By using a quantitative model instead of an empirical analysis, I can demonstrate long-run effects and compute welfare changes. My modeling approach also allows for a more detailed household analysis and accounts for differences between market and cadastral values across the house price distribution.

Setting. The Italian housing market is an interesting context for studying the role of owner-occupied exemptions and the progressivity of property taxes, reflecting many issues highlighted in the literature. First, housing receives preferential treatment compared to other assets (Pellegrino et al., 2012). This includes both an owner-occupied exemption and mortgage interest payment deductions in the Italian property tax system.

Second, homeownership is high, and housing is the primary source of wealth for most Italians (Liberati and Loberto, 2019). Real estate is the main asset in 67.6% of households' portfolios, and for 48.6% of households, it is the only asset.[2] Third, real estate holdings increase with both wealth and income. This trend is partly due to the acquisition methods, which often involve transfers. Nearly a third of homeowners acquired their main residence through inheritance or gifts, with wealthier and higher-income households more likely to have received a bequest. Additionally, mortgage uptake is low, with only 12.4% of homeowners having an outstanding mortgage. More details on the Italian setting can be found in Appendix A.

[2]Using Italian Survey on Household Income and Wealth (SHIW). Data for 2016. The Appendix B provides further information on data used and Table A1 shows further statistics. Real estate is classified as the main asset if the real estate value is larger than the combination of financial assets and real assets excluding real estate. Real estate is classified as only asset if the real estate value is positive and the value of securities plus business assets is 0.

Fourth, cadastral values are outdated, based on rents from the late 1980s (Bordignon et al., 2017). This results in two issues. First, cadastral values do not reflect current market values, capturing on average only half of the market value leading to an average assessment ratio of 0.5 (Festa and Erika, 2014, Dipartimento delle Finanze, 2020). Second, more valuable houses generally have a lower assessment ratio, while less valuable houses may have a ratio greater than 1, making the property tax system more regressive (Agnoletti et al., 2020, Curto et al., 2021). In Appendix A, I analyze this relationship further and estimate the effective property tax function, i.e. a function that provides the property tax rate that would be applied if the tax base were the market value rather than the cadastral value. Additional information on cadastral values can be found in Appendix D.

In the next section, I describe the model that I developed for the analysis. In Section 3 I calibrate it, showing how it matches Italian data. Section 4 presents the results from the policy experiments. Section 5 discusses the welfare implications. Section 6 concludes.

2 Model

I build a life-cycle model of homeownership in a small open economy with an exogenous safe interest rate r. It is populated by four types of agents: households, real estate firms, a construction firm and the government. Time is discrete and each period lasts one year. There is no population growth.

2.1 Households

Households live through a stochastic life cycle with five age groups $j = 1, ..., 5$. The first four periods represent the working ages and each age group should be considered as 10 years long, i.e. 25-34, 35-44, and so on. Households survive throughout the entire working age and move from one age group to the next with an aging probability given by $\vartheta_j = 1/10,\ j = 1, ..., 4$. The last age group covers the retirement period. Households within this age group exit the economy with a death probability of $\vartheta_5 = 1/20$. In order to maintain the mass of households in each group constant, newborns enter the first age group at a rate of $\vartheta_5/(1+40\vartheta_5)$.

Households in the first four age groups supply labour inelastically. The labour income is the sum of an age-dependent component, M_j, and a residual stochastic component, $\epsilon_{i,j}$:

$$\log y(j,i) = M_j + \epsilon_{i,j},$$

where the index i represents the residual income deciles, $i \in \{1, ..., 10\}$, so for each age group there are ten possible labour incomes. Movements across these ten labour incomes follow a Markov process with age-specific transition matrix Ψ_j. There are also ten levels of retirement income. The value of the retirement income corresponds to the average income level of the pre-retirement period income decile multiplied by a replacement rate and remains constant during retirement.

Households maximize expected lifetime utility and have preferences over consumption c and housing services s according to a non-separable period utility:

$$u(c,s;j) = \frac{1}{1-\sigma}\left[c^{\zeta}s^{1-\zeta}(1/n_j)\right]^{1-\sigma},$$

where σ is the degree of relative risk aversion and ζ is the expenditure share of consumption. I control for the changes in household size throughout the life cycle with n_j. The use of the Cobb-Douglas form to aggregate consumption and housing services is in line with the literature (Díaz and Luengo-Prado, 2008, Bonnet et al., 2021). The justification behind using this form rather than the more general CES is twofold. First, identification and computation of the intra-temporal elasticity is not straight forward (Piazzesi et al., 2007). Second, the lack of strong evidence for the elasticity of substitution between durable and non-durable consumption being significantly different than unity (Fernandez-Villaverde and Krueger, 2011, Borri and Reichlin, 2021).[3]

Households can choose to buy a house that comes in discrete units $h \in \mathcal{H} = \{0, \underline{h}, ..., \bar{h}\}$, with $\underline{h}$ being the minimum housing size, and $\bar{h}$ the maximum. Housing units have a per unit price of p.[4] Thus, for a house of units h, the market value is ph. There exists a linear technology that transforms one unit of housing owned to one unit

[3] Several studies estimate an elasticity slightly higher than 1 (Piazzesi et al., 2007)

[4] Modelling houses through the use of discrete units is common in the literature (Attanasio et al., 2012, Piazzesi and Schneider, 2016, Paz-Pardo, 2024). The 0 represents renting. More units represent a higher housing investment. One can think of these units to represent housing size, implying that more units means larger houses. Other interpretations could be house quality or location

of housing services. The minimum amount of housing services households can choose is smaller than the minimum size of housing units, $s \in \mathcal{S} = [\underline{s}, \bar{s}]$, with $\underline{s} < \underline{h}$ and $\bar{s} = \bar{h}$. This is done in order to account for the fact that rented houses tend to be of lower quality than owned houses, and that families can rent a part of a house.

Households that do not own a house, $h = 0$, have to rent their housing services in the rental market at the rental rate ρ. For homeowners, $h > 0$, I assume that they cannot purchase additional housing services on top of the ones provided by the house they own, this implies that $s \leq h$, if $h > 0$. Nonetheless, homeowners can rent the part of their house that they do not consume, $h - s$, in the rental market at the rental rate ρ, becoming landlord households.

Households incur transaction costs for buying and selling of houses that depend on the current market value, denoted $t^b ph$, and $t^s ph$ respectively. The transaction costs when buying include real-estate agents fees, some legal fees, and real-estate transfer taxes, $\tilde{t}^b$. Houses depreciate randomly, with an expected yearly depreciation rate of δ. An household who chose next-period housing level $\tilde{h}'$ will start next period with housing level $h' = \tilde{h}'$ with probability π_{dep}, and with housing level $h' = \tilde{h}'_{-1}$ with probability $(1 - \pi_{dep})$, where $\tilde{h}_{-1}$ is the house before $\tilde{h}$ in the housing unit set $\mathcal{H}$. The probability π_{dep} are obtained such that the expected value of next period housing is equal to the expected depreciation rate $\tilde{h}'(1 - \delta)$.[5]

It is important to note that the use of the housing unit set $\mathcal{H}$ implies the indivisibility of housing. Hence, housing is different than capital (Piazzesi and Schneider, 2016), and households can become homeowners only if they have enough savings to purchase housing units $\underline{h}$ at the price $p\underline{h}$ (Gervais, 2002, Borri and Reichlin, 2021). In turn, this implies that policies that lower the price of house units p can increase homeownership by enabling poorer households to overcome this constraint. Furthermore, the indivisibility of houses also affects how houses can depreciate.

Households can save by holding a safe asset a that pays a yearly interest rate r. The only way for a household to borrow is through a mortgage, which has an exogenous

[5]This random depreciation is important in this model for two reasons. First, the housing equilibrium is obtained from the supply of housing from the a construction sector, and the demand from households.As, there is no population growth, if there is no depreciation of housing, the housing stock should remain constant and the construction sector would not be relevant. Second, houses come from a discrete set. Having a non-random depreciation would create houses outside of this set. The probability π_{dep} is different for each house size, and for the i^{th} house it is obtained as $\frac{h_i(1-\delta)-h_{i-1}}{h_i-h_{i-1}}$

interest rate r^m and is subject to a down payment constraint given by:

$$a' > -(1-\theta_j)p\tilde{h}',$$

where a' is the next period asset choice, θ_j is the age-specific down payment requirement, and $\tilde{h}'$ is the next period housing choice before the random depreciation.

Finally, retired households have a bequest motive that is given by:

$$\phi(B) = \frac{\phi_1(B+\phi_2)}{1-\sigma}^{1-\sigma}.$$

The bequest motive is characterized by two parameters (De Nardi, 2004, Kaplan et al., 2020). The first one, ϕ_1 reflects the importance of bequests motive. The second one, ϕ_2, captures the luxury nature of bequests. The bequest B includes both the financial and housing assets after transaction costs $B = a' + ph(1+t^s)$.

The bequests are distributed randomly to the households in the first two age groups. For each of these households, the probability of obtaining the bequests and its value depend on their current income decile. For a household of age j and in income decile i, the probability of obtaining a bequest is given by $\pi_{beq}(j,i)$, while the value of the bequests obtained is given by $b'(j,i) = \bar{b} \times w_{beq}(j,i)$, with $\bar{b}$ being the base bequest and $w_{beq}(j,i)$ some weights that scale up or down the base bequest.

2.2 Real-estate firms

The second set of agents that populate the economy are real-estate firms that rent out houses in the rental market at rental rate ρ. Unlike household landlords, these firms have to pay a cost κ^m in order to rent out the house. This cost encompasses all costs that a renting agency incurs and a household landlord does not. These could be due to an information asymmetry between real-estate agencies and tenants, or any administrative and operational costs that real-estate agencies face and household landlords do not.[6]

[6] As described by Kaas et al. (2020), information asymmetry costs may arise as the real-estate firms need to monitor tenants in houses that are far away, while household landlords might live in proximity to the tenants. Instead, administrative and operational costs may arise as the real-estate firms need to oversee several tenants and pay wages to agents, while the household landlord does not as they usually only have one property to rent out.

The value of a real estate firm is given by:

$$V_r = (\rho - \kappa^m + (1-\delta)V_r)/(1+r),$$

and combining this with the zero profit condition $V_r = p$, we obtain a relationship between the house unit price p and the rental unit price ρ:

$$\rho = p(r+\delta) + \kappa^m. \tag{1}$$

A higher monitoring cost leads to higher rents and a lower price-to-rent ratio encouraging households to purchase their own home.

2.3 Construction firm

A representative construction firm builds housing units I. The firm operates with an increasing and convex cost function $K(I)$, which accounts for building land restrictions and scarcity of building materials.[7] Profit maximization leads to the following relationship between new housing construction and housing unit price:

$$p = K'(I). \tag{2}$$

Given that there is no population growth in the model, in the steady state housing stock has to be constant. This implies that new housing construction has to compensate for the depreciation of housing stock, hence $I = \delta\bar{H}$.

2.4 Government

The government collects taxes from income, properties, and property transfers to finance government spending. In line with Italian law, households can deduct from their taxable income a portion ω of the interest payment for a mortgage. As a result, taxable income, $\tilde{y}$, can be less than labor income, y. Income taxes are computed using the tax function $T(\tilde{y})$, with $\tilde{y} \times T(\tilde{y})$ representing total income tax liability.

[7] Refer to Davis and Heathcote (2005) for a full specification of house construction function with land and structures.

The property tax function in the model is $\mathcal{T}(pv)$, where v represents the house units being taxed, and pv is the market value of the units being taxed. To capture the regressivity introduced by the mismatch between market and cadastral values, it is assumed that $\mathcal{T}(pv)$ is a downward-sloping function. In the benchmark economy, the house units taxes are given by $v = h - s$ and hence $p \times (h-s) \times \mathcal{T}(p(h-s))$ determines the total amount of property taxes due by an household. Finally, the government collects the real-estate transfer tax, $\tilde{t}^b$. For every house purchased by households, i.e. $\tilde{h}' \neq h$, the government collects $\tilde{t}^b \times p\tilde{h}'$.

2.5 Household Problem

Any household begins each period with the state vector (j, i, a, h), where j is the age group, i is the income decile, a is the safe asset stock, and h is the current housing stock. The state variables j and i change from one period to the other according to the aging probabilities ϑ_j and the transition matrix Ψ_j respectively. In each period the household has to choose the amount of consumption c and housing services s, and the amount of assets a' and gross housing stock (before depreciation) $\tilde{h}'$ with which they will start the next period. Households in the first four age group solve the following problem:

$$V(j,i,a,h) = \max_{c,s,a',\tilde{h}'} u(c,s;j,h) + \beta\,\mathbb{E}_{j,i}[V(j',i',a'+b',h')] \tag{3}$$

subject to:

$$\begin{aligned} c + a' + p\tilde{h}' = {} & y(j,i) + [1 + r\mathbb{1}_{a>0} + r^m\mathbb{1}_{a<0}]a + ph + \max\{\rho(h-s),0\} \\ & - \rho s\mathbb{1}_{h=0} - \tilde{y}T_j(\tilde{y}) - \mathbb{1}_{\tilde{h}'\neq h}[t^b p\tilde{h}' + t^s ph] - p\max\{(h-s),0\}\mathcal{T}(p(h-s)), \end{aligned} \tag{4}$$

$$\tilde{h}' \in \mathcal{H};\;\; s \geq 0;\;\; s \leq h \text{ if } h > 0, \tag{5}$$

$$a' \geq -p\tilde{h}'(1-\theta_j), \tag{6}$$

$$h' = \tilde{h}' \text{ with prob. } \pi_{dep} \text{ or } \tilde{h}'_{-1} \text{ with prob. } 1-\pi_{dep}, \tag{7}$$

$$\begin{aligned} \tilde{y} = {} & y(j,i) + r\max\{a,0\} + \rho\max\{0,(h-s)\} \\ & - \omega r^m \min\{\max\{-a,0\}, p(1-\theta_j)\min\{h,s\}\}, \end{aligned} \tag{8}$$

and

$$b' = \bar{b}w_{beq}(j,i) \text{ with prob. } \pi_{beq}(j,i).\;\; \pi_{beq}(j,i) = 0 \text{ if } j \in \{3,4\}. \tag{9}$$

Regarding the constraints, Equation (4) is the budget constraint which has on the right hand side the labour income, the capital gains from the safe asset if this is positive, or the mortgage cost if the asset is negative, the value of the current house, the rental income or the rental cost if no house is owned, the taxes that are due, the transaction costs in the case that the household changes house size, and finally the taxes on rented property. Equation (5) represents the housing constraint, showing that houses can belong only to a definite set, and homeowners cannot obtain more housing service than the one provided by their owned houses. Equation (6) shows the borrowing constraint faced by households and how the only tool for borrowing is a mortgage. Equation (7) shows how the housing decision $\tilde{h}'$ for the next period turns into the actual housing stock for next period. Equation (8) shows the taxable income, composed of the labour income, capital and rental income and the deductions for the owner-occupied share of the house. Finally, equation (9) presents the probability for households in the first two age groups to obtain a bequest b', with the value of the bequest determined by the income decile.

Meanwhile, households in the last age group, J, solve a similar problem, with the constraints given by equations (4) to (8) and the value function $V(J, i, a, h)$ being:

$$V(J, i, a, h) = \max_{c,s,a',\tilde{h}'} u(c, s; J, h) + \beta \left[(1 - \vartheta_5)V(J, i, a', h') + \vartheta_5 \phi(a' + p(1 - t^s)h')\right] \quad (10)$$

with

$$\phi(B) = \frac{\phi_1 (B + \phi_2)}{1 - \sigma}^{1-\sigma}. \quad (11)$$

The value function for the last age group accounts for the bequest motive and the fact that retirees do not move across income deciles.

2.6 Equilibrium

The stationary equilibrium is the collection of the household value function $V()$, the household policy functions for consumption, housing services, financial assets and housing asset $C(), S(), A(), H()$, probability measure μ over the state variables (j, i, a, h), bequest distribution $B()$, house and rental unitary prices p, ρ, and housing stock $\bar{H}$ such that:

1. Households value functions and policy functions solve the household problem.

2. Real-estate firms maximise their profits, creating the relationship between house prices and rents (Equation 1).

3. Construction firms maximise their profits, creating the relationship between house prices and new housing construction (Equation 2).

4. Housing market equilibrium holds, which means that all housing units are occupied by either owners or renters: $\bar{H} = \int S(j,i,a,h)d\mu(j,i,a,h)$.

5. μ is a stationary distribution, invariant to stochastic processes (j,i)

6. The total bequest collected from the elderly is equal to the total bequests distributed to the younger generations: $\bar{B} = \vartheta_J \int a' + p(1-t^s)h' d\mu(J,i,a,h) = \int \pi_{beq}(j,i)\bar{b}w_{beq}(j,i)d\mu(j,i,a,h)$

7. The government budget balances, hence the government spending is equal to the tax raised through income, property taxes, and property transfers:

$$G = \int \left[T(\tilde{y}(j,i)) + \mathcal{T}(pv(j,i,a,h)) + \tilde{t}^b pH(j,i,a,h)\mathbb{1}_{H(j,i,a,h)\neq h} \right] d\mu(j,i,a,h),$$

   where term is income taxes, the second is property taxes on taxed units $v()$, that is obtained from the house and housing services choices, and the last term is the real-estate transfer tax, that is multiplied by house value of transacted houses.

3 Calibration

The model is calibrated to the 2016 Italian economy. Thus, the benchmark economy features both the post-reform cadastral multipliers and the owner-occupied exemption. The majority of the parameters are calibrated using external sources, while the remaining ones are calibrated to match a set of moments retrieved from the data. The data sources are the Italian Survey on Household Income and Wealth (SHIW) and the European Union Statistics on Income and Living Conditions (EU-SILC). The appendixes provide information on the data sources used. Table 1 and Table 2 summaries the estimates obtained. Prices are in 2016 thousands of euro.

3.1 Externally calibrated parameters

Households. As indicated above, we set the aging probability for the first four age groups as $\vartheta_j = 1/10$ while the death probability as $\vartheta_5 = 1/20$ to obtain the desired period representation. The period preferences of households are characterized by 3 parameters, the risk aversion, the expenditure share of consumption and the household size. These are calibrated externally. The first takes the standard value found in the literature, $\sigma = 2$. The expenditure share of consumption is computed from the SHIW data by comparing the share of expenditure on consumption and on rent among renters obtaining $\zeta = 0.775$ (Davis and Ortalo-Magné, 2011, Sommer and Sullivan, 2018). I obtain the age-group specific household size, n_j, from the EU-SILC dataset.[8]

Houses. The minimum and maximum housing unit, which characterize the housing set $\mathcal{H}$, are set to match approximately the 10th and 90th percentile of housing value calculated using the SHIW, obtaining $\underline{h} = 60.000, \bar{h} = 500.000$. Transaction costs for selling and buying are, respectively, $t^s = 3\%$ and $t^b = 9\%$ of the house market value. The buying transaction costs include also the real-estate transfer tax $\tilde{t}^b = 3\%$. These numbers are set to match the transaction cost estimates for Italy presented in the Online Appendix of Kaas et al. (2020), and estimates found online.[9] Finally, house depreciation is set to give houses 100 year lifespan, $\delta = 0.01$ as in Kaas et al. (2020).

Assets. The safe interest rate is set to match the average from 1995 to 2016 of the real yield of 10 year Italian bonds, $r = 0.03$. Meanwhile, the mortgage interest rate is obtained from the average between 1995 and 2010 of real mortgage interest from the Bank of Italy data, $r^m = 0.04$.[10] The mortgage down payment for the first three age groups is $\theta_j = 0.4$ for $j \in \{1, 2, 3\}$, as reported by Chiuri and Jappelli (2003). For the latter two age groups a higher value is set in order to avoid extremely rapid mortgage adjustments as in Kaas et al. (2020), obtaining $\theta_4 = 0.6$ and $\theta_5 = 1$.

[8] Each n_j is set to match the mean of the adjusted household size of the age group found in the data. Household sizes are adjusted using the OECD equivalence scale (or Oxford scale).

[9] `https://www.globalpropertyguide.com/Europe/Italy/Buying-Guide`.

[10] `https://www.bancaditalia.it/statistiche/basi-dati/bds/index.html`

Bequests. Bequests are collected from retirees and distributed to the first two age groups. The two features of the bequest that have to be calibrated are the probability for a household to obtain it and its value. First, the probability of obtaining a bequest in any given period is given by $\pi_{beq}(j,i)$. As only the first two age groups obtain bequest $\pi_{beq}(j,i) = 0$ if $j \in \{3,4,5\}$. Furthermore, I assume that $\pi_{beq}(1,i) = \pi_{beq}(2,i)$.[11] Given the aging and the death probabilities, we obtain that the probability of obtaining a bequest for a household in the first two age groups across all income deciles is $\pi_{beq}(j) = 0.05$.[12] To obtain a probability distribution across income deciles that matches the data, I used the information presented in Figure A2a. The figure shows the fractions of households between the ages of 25 and 44 that received a transfer across three income groups. I re-scale the fractions so that the probability across the income groups is equal to 0.05.

In order to account for the difference in the value of the transfers obtained by households across income deciles, a base bequest $\bar{b}$ is multiplied by weights $w_{beq}(j,i)$ that depend on age and income. I assume that $w_{beq}(1,i) = w_{beq}(2,i)\ \forall i$. Across income, the weights are obtained from Figure A2b. The weight for the first income group is normalized to one $w_{beq}(j,1) = 1$ for $j \in \{1,2\}$. The rest of the weights are given by the relative values of transfer with respect to the value of transfer for the first income group. The base bequest $\bar{b}$ is an equilibrium object.

Table 1 shows the values of $\pi_{beq}(j,i)$ and $w_{beq}(j,i)$ for three income groups defined as low (first to third income decile), medium (fourth to seventh income decile), and high (eight to last decile). Both the probability of obtaining a bequest and its value are approximately double for households in the last income group compared to households in the first income group.

Labour income process. The labour income is estimated using data from EU-SILC from 2007 to 2016. For each of the first four age group, three parts need to be estimated: the age specific component M_j, the age specific residual income decile $\epsilon_{i,j}$, and the age specific transition matrix Ψ_j. The first two are obtained by regressing for each age group separately the log household gross labour income on a constant, year dummies, age and

[11]From the SHIW it is possible to see that the fraction of households that obtain a bequest or an *inter-vivos* transfer is similar across the four working age group. However, in the model only the first two age groups obtain bequests. This is done in order to avoid having to add an additional state variable that keeps track of whether a bequest has been received.

[12]For each household in the last age group that dies, there are 20 households in the first two age groups.

age squared of the head of the household. The coefficients of this regression, together with the average values of the independent variables, are used to obtain M_j.

In order to obtain the residual income decile, for each age group the regression residuals are calculated and divided in increasing decile bins $I = \{1, ..., 10\}$. $\epsilon_{i,j}$ is the mean of the regression residual within decile i and age group j. The transition matrix for each age group is estimated from the fraction of households within the age group that move from one income decile in one year i to i' in the following year.

For the retirees, each pension decile is estimated by multiplying the gross replacement rate with the average income in that decile across all four working age groups. The gross replacement rate in Italy is 0.645 (OECD, 2011). Retirees do not change pension decile throughout their retirement, hence the transition matrix Ψ_5 is the identity matrix.

Taxes on income. The share of the mortgage interest that can be deducted from taxable total income $\tilde{y}$ is set to $\omega = 19\%$ in line with the Italian tax law. Taxes on taxable total income are calculated using the tax rate function $T(\tilde{y}) = 1 - \lambda_0 \tilde{y}^{-\lambda_1}$, with total taxes due being $\tilde{y}T(\tilde{y}) = \tilde{y} - \lambda_0 \tilde{y}^{1-\lambda_1}$. This two parameter functional form has been used extensively in the literature as it can be easily estimated and it identifies separately a tax level parameter λ_0, and a tax progressivity parameters λ_1, offering the possibility of altering one without affecting the other (Benabou, 2002, Heathcote et al., 2017). Higher level of λ_1 lead to higher level of progressivity.

I estimated the parameters using EU-SILC data for the years between 2007 and 2016. I regressed the log of the net household total income on a constant and the log of gross total income.[13] The estimated tax function is:

$$T(\tilde{y}) = 1 - 1.474\tilde{y}^{-0.064}.$$

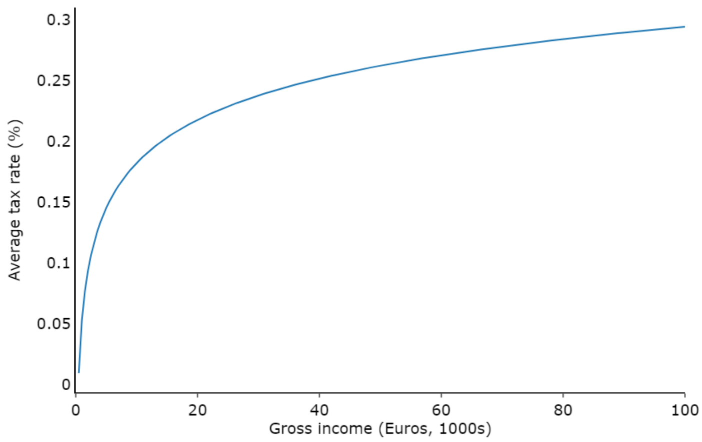
In Figure 1 I show the average tax rate across gross income levels.[14]

Taxes on property. In the model property taxes are paid on market value, and not on cadastral values. Thus, in order to account for the observed discrepancy between the two, I construct the effective property tax rate function. The aim of this function is to

[13] Mortgages deductions should be excluded, however the EU-SILC does not allow for this.

[14] The average tax rate I obtained from the estimated tax function are below the average tax rate reported by Baldini (2021). In his simulation he uses a representative taxpayer who is a single employee, whereas I estimate the tax function for entire families.

Figure 1: Average tax rate



Notes: The figure depicts the average tax rate used in the model. The income taxation has been estimated by using the two parameter functional form and EU-SILC data.

correct the statuary property tax rate, $\tau_p = 0.76\%$, for the assessment ratio, i.e. the percentage of market value captured by the taxable value. As a clarifying example, let CV_i be the cadastral value of a taxed house i, and MV_i the market value. Then, the effective property tax rate for this house is given by:

$$\mathcal{T}_i = \tau_p \times \frac{CV_i}{MV_i}, \tag{12}$$

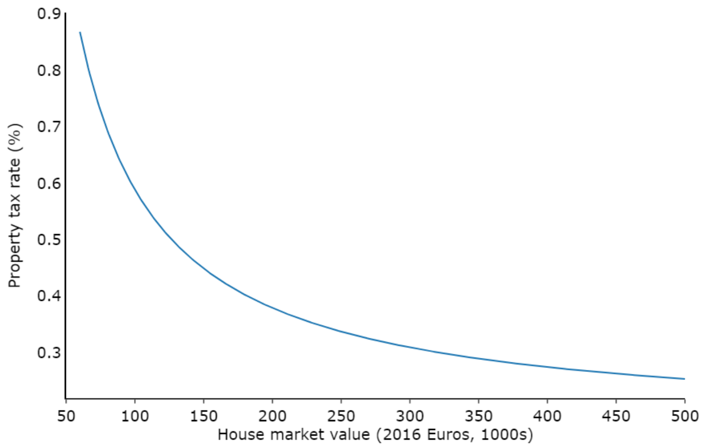
where the first part is the statutory property tax rate τ_p and the second part is the assessment ratio.

Furthermore, let v be the house units being taxed, and pv the market value of the house units being taxed. The effective property tax rate function $\mathcal{T}(pv)$, takes as input the market value of taxed units, and provides as output the tax rate to apply for a property with this market value. I calibrate $\mathcal{T}(pv)$ by using the estimated relationship between market and cadastral value shown in Equation (14) in the Appendix A. I obtain

$$\mathcal{T}(pv) = \tau_p \times \frac{0.172pv + 59.51}{pv},$$

where the first term is the national property tax rate, the fraction is the estimated assessment ratio, and v is the house units that are taxed. The function is downward sloping, hence it is able to capture the empirical evidence that more expensive houses

Figure 2: Calibrated Effective Property Tax Function $\mathcal{T}()$



Notes: The figure shows the property tax rate for different market values of properties obtained with the calibrated property tax function.

tend to have a relatively lower cadastral values.

In the benchmark economy, because of the owner-occupied exemption, only rented units are taxed and hence $v = h - s$. Figure 2 shows $\mathcal{T}(pv)$ function for different market values. As it can be seen, houses with lower market have a property tax rate well above the houses with higher market values. Additionally, it is possible to see that houses with a very low market value have an effective tax rate which is above the national property tax rate. This is inline with the Figure A4, that shows that in some municipalities the average market value is below the average cadastral value.

Construction firm. The construction cost function is $K(I) = k_0 I^{1+\psi}/(1+\psi)$ which implies $p = k_0 I^{\psi}$. To calibrate the ψ parameter, I use the inverse of the long-run price elasticity of new housing supply.[15] I use the elasticity calculated by Caldera and Johansson (2013) for Italy which is 0.258, leading to $\psi = 3.88$. This elasticity is quite low, implying that housing investment is not very responsive and that the cost function of the construction firm increases rapidly.[16]

[15] The elasticity describe how many additional houses are built for an increase in house prices. The long run refers to the fact that the estimation assumes equilibrium in housing stock, which fit with the steady state analysis here.

[16] Inchauste et al. (2018) estimate a much higher long run new housing supply elasticity for Italy at 1.8, obtaining a construction elasticity of 0.56. I have run the model also with this parameter. Whereas the results are numerically different, the overall conclusions remain stable.

Table 1: Externally Calibrated Parameters

	Parameters	Values
Ageing probabilities	ϑ_1,ϑ_2,ϑ_3, ϑ_4	0.1
Death probability	ϑ_5	0.05
Equivalized HH size	n_1, n_2, n_3, n_4, n_5	1.55,1.79,1.96,1.79,1.44
Risk aversion	σ	2
Expenditure share of consumption	ζ	0.775
Interest rates	r, r^m	0.03, 0.04
Down payment	θ_1,θ_2,θ_3 θ_4, θ_5	0.4,0.4,0.4,0.6,1
Transaction costs	t^s,t^b,$\tilde{t}^b$	3%, 9%, 3%
Depreciation rate	δ	0.01
Housing size (Thousands of Euro)	$\underline{h}$, $\bar{h}$	60, 500
Construction elasticity	ψ	3.88
Deductible mortgage interest share	ω	19%
Income taxes	λ_0, λ_1	1.474,0.064
National property tax rate	τ_p	0.76%
Transfer probability	$\pi_{beq}(j, i)$	3.42%, 5.01%, 6.57%
Transfer weights	$w_{beq}(j, i)$	1, 1.52, 2.08

Notes: The table shows the parameters calibrated using external sources such as other papers or own calculations using SHIW, EU-SILC or Bank of Italy data. All information can be found in the text and in the appendixes.

3.2 Internally calibrated parameters

The remaining 5 parameters are calibrated internally by targeting specific moments of interest. The first parameter is the discount factor β, which identifies the patience of household and hence is calibrated to target the average wealth of households. The second parameter is the cost of real-estate firms κ^m, which defines the relationship between the house unit price and the rental price. As discussed above, a higher cost increases the rent rate and lowers price to rent ratio, making housing investment more convenient for households. Therefore, this parameter is identified by the average house ownership rate.[17]

The third and fourth parameters relate to the bequest motive function $\phi(B)$. The two parameters are directly linked to the wealth level and wealth distribution of the last

[17] In the model households that own a property cannot rent additional space. In order to match this with the data, the statistics I report on homeownership are on household that live in the house they own, and not on households who own some properties. Notice however that in the case of Italy the difference is minor, around 2 p.p.

age group. The importance of the bequest motive parameter, ϕ_1, affects the willingness of retirees to save as they obtain a utility from dying with positive assets. Hence, this parameter is set to match the average wealth of households in the last age group. The luxury of bequests parameter, ϕ_2, determines the bequests left across the retirees' wealth distribution. The parameter affects mainly the lower end of the wealth distribution, relating it to wealth inequality within this age group. Hence, I target the percentile ratio P50-P25. This shows the ratio of the net wealth belonging to household at the 50th percentile over the household at the 25th percentile. Finally, the last parameter is the scale term of the cost function of the construction firm k_0, which is set to normalize the unit price of houses $p = 1$ in the benchmark economy.

Table 2 presents the selected values for the parameters, and the targeted moments in the model and in the SHIW data. Note that the relative size of the age groups differs between the model and the data. In order to account for this, totals or averages in the data are given by a weighted average of the age group mean. The weights are given by the relative size of age groups in the model.[18] The model matches the targets very well.

Table 2: Internally Calibrated Parameters

Target	Parameters	Value	Data
Average wealth	$\beta = 0.9545$	194.4	192.3
Homeownership rate	$\kappa^m = 0.01495$	65.0	65.2
Average wealth of retirees	$\phi_1 = 1145.0$	238.4	238.1
Wealth distribution of retirees, P50-P25	$\phi_2 = 610.0$	2.6	2.8
Price normalization	$k_0 = 0.239$		

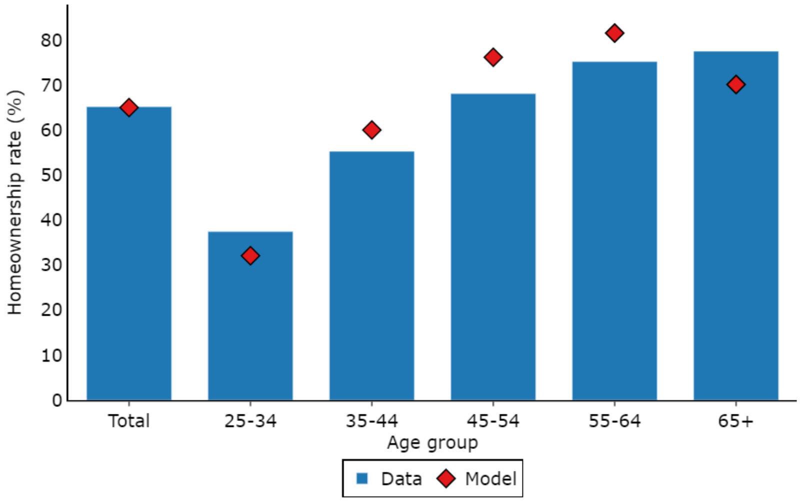
Notes: The table shows the internally calibrated parameters and compares the target outcomes estimated from the model and from the SHIW 2016 data.

3.3 Untargeted Moments

Next, I report several untargeted moments. I focus on homeownership by age, income and wealth deciles; total and housing wealth by age; and percentage of homeowners with an outstanding mortgage by age.

[18] In the model, each age group represents one sixth of the population, except for the retirees that represent two sixths. In the data, first, the population between the ages of 25 to 85 represent 73% of the overall population. Second, within this range, the ages between 35 and 64 are overrepresented in the data, compared to the model, as they account for 59% of people rather than 50%.

Figure 3: Homeownership Rate by Age



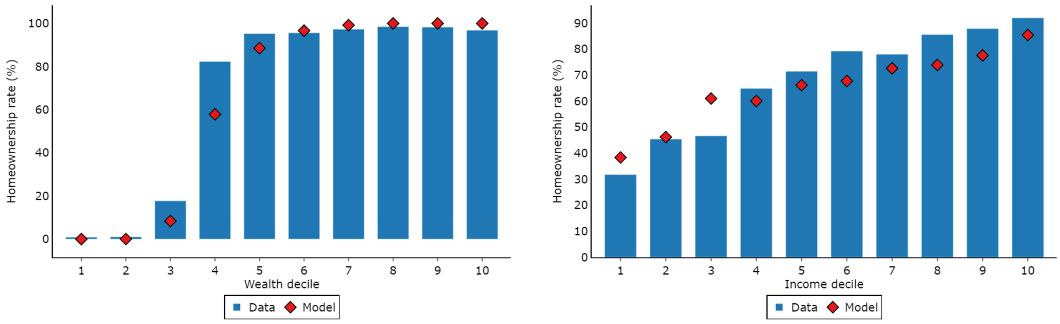
Notes: The figure compares the homeownership rate by age estimated from the calibrated model and from the SHIW 2016 data. The bars represent the actual data, while the diamonds represent the model's estimates.

Figure 3 shows the homeownership rate by age in the data and in the model. Overall the model is able to replicate very well the levels and the life-cycle trends. A key feature of the model that ensure the good fit is the bequest motives of the last age group. This ensures that retirees do not dis-save all their wealth and a large amount of bequest is transferred to younger generations.

Figure 4 shows the homeownership rate by deciles of wealth and income. Also in this case, the model does a good job in replicating the data. Even though ownership is underestimated for the 3$^{\text{rd}}$ and 4$^{\text{th}}$ wealth decile, the model replicates the extreme jump present in homeownership rate across wealth deciles. Furthermore, as in the data, the distribution of homeownership is flatter across income deciles than wealth deciles.

Figure 5 compares the total wealth and housing wealth in the data and the model by age group. Focusing on total wealth, the bars on the left, both the life-cycle pattern and the levels are matched very well. Instead, regarding the housing wealth, the darker blue bars on the right, the model replicates the life-cycle pattern, but underestimates the level. One reason for this is that in the data, housing wealth is defined as the value of any real estate. Yet, in the model, the real estate wealth of homeowners is only

Figure 4: Homeownership Rate by Deciles



(a) Wealth deciles

(b) Income deciles

Notes: The two figures compare the homeownership rate by wealth and income decile, respectively, estimated from the calibrated model and from the SHIW 2016 data. The bars represent the actual data, while the diamonds represent the model's estimates.

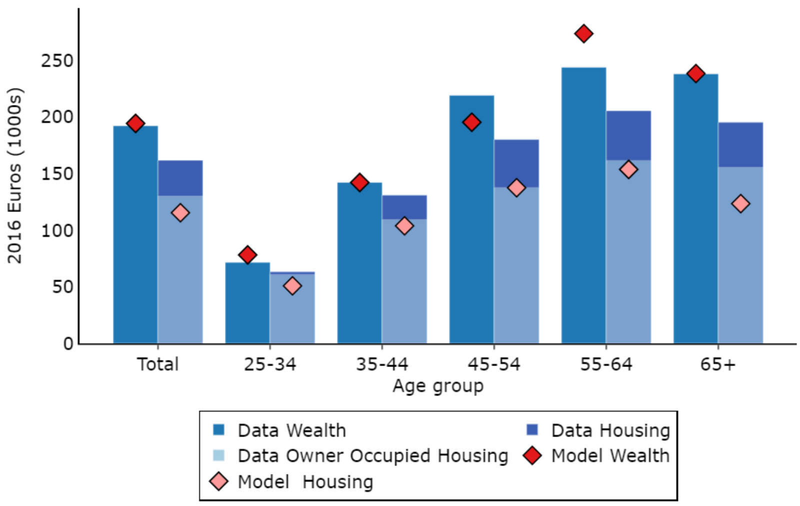
the house they own and the part of that house that they rent out. Thus, the data is capturing a broader concept of real estate wealth that the model ignores. By comparing the model's results to data on only the value of the main property (the lighter blue on the right side), the model actually matches also the levels very well.

Finally, Figure 6 shows the percentage of homeowners with an outstanding mortgage in the data and the model. The model manages to replicate the life-cycle trend and the overall percentage of homeowners with an outstanding mortgage. However, the use of mortgages by homeowners in the first four cohorts is overestimated, while homeowners in the last age group do not hold any mortgage.[19] This suggests that the model is not able to capture some financial constraints that exist. An example of such a constraint is the importance of temporary contracts among young households, which reduce their likelihood of obtaining a mortgage.

Regarding taxes, in the benchmark economy property taxes are only collected from household landlords on the share of their housing asset that they rent out. The model predicts property tax revenues from households to be 0.03% of the GDP. This percentage

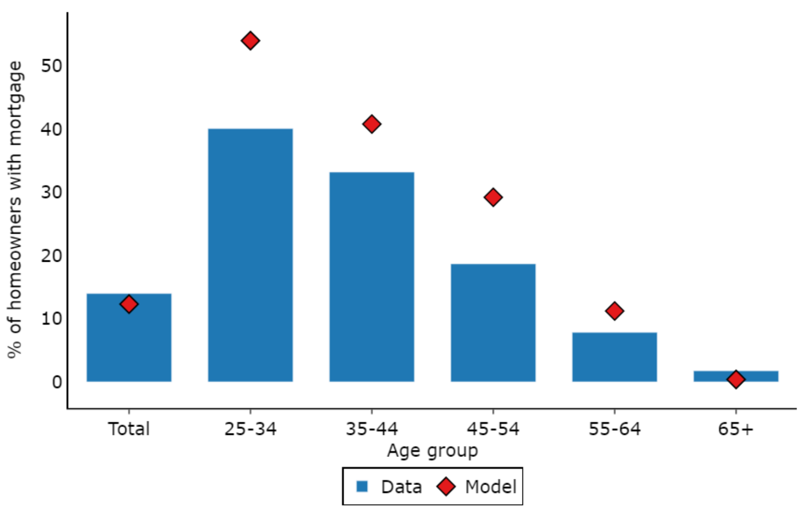
[19] Despite the overestimation of mortgage usage in the younger cohorts, the correct average is achieved because the oldest age group, with close to 0% mortgage holders among homeowners, is twice as large as each of the younger age groups and thus carries more weight in the calculation of the average. Furthermore, the homeownership rate in this older group is particularly high, which helps balance out the overestimation in the younger cohorts.

Figure 5: Total and Housing Wealth by Age



Notes: The figures compares the total wealth and real estate wealth by age estimated from the calibrated model and from the SHIW 2016 data. The darker bars and diamonds represent total wealth. The lighter bars and diamonds represent real estate wealth. The black crosses are the value of the owner-occupied house

Figure 6: Mortgage Uptake by Age



Notes: The figures compares the mortgage uptake estimated from the calibrated model and from the EU-SILC 2007-2012 data. The bars represent the actual data, while the diamonds represent the model's estimates.

is an order of magnitude lower than the 1% of GDP collected in Italy currently from property taxes (Figure A3). Yet, there are three aspects worth noting. Firstly, the revenues in the data above include dwellings used as residences and dwellings used for productive or other purposes, whereas the model focuses only on dwellings used for residences. Secondly, in the model only households pay property taxes, while in reality firms and governmental agencies also pay property taxes. Lastly, in the model a household can choose only between occupying the entirety of their housing asset, or leasing a part and occupying the rest. Hence, the model does not allow for secondary houses that are not leased but are subject to property taxes.

While data on amount of revenue taxes by different type and use of dwelling, and kind of legal entity cannot be easily found, some estimates to understand the magnitude of the three problems mentioned above can be obtained. By starting from data on cadastral rents by type and use of dwelling for different kinds of legal entity (Table C4), I obtain that property tax revenue is approximately 0.12% of the 2016 GDP. The model still underestimates the property tax revenues as % of GDP, yet the estimates are comparable in magnitude. Furthermore, I obtain that the removal of the owner-occupied exemption, without accounting for general equilibrium effects, should increase the tax revenue by approximately 14 Billion Euros.

4 Counterfactuals

I next use the quantitative laboratory to evaluate several potential reforms. I perform four policy experiments. First, I remove the owner-occupied exemption, i.e. households are taxed on all house units h they own, but the effective tax rate follows the regressive schedule of the benchmark economy. The second counterfactual adds to this the adjustment of the cadastral values so that they reflect the market values. This implies that the regressive property tax schedule is replaced by a flat property tax. The flat property tax rate applies to all housing units h owned by the household and is set to 0.38%. This value is obtained by dividing the the statutory national property tax rate (0.76%) by the average market to cadastral value ratio (2) (Cammeraat and Crivelli, 2020). The third counterfactual is identical to the second one, but taxes apply on house values net of mortgages. As the first two counterfactuals capture the reform passed in 2012 and the current political discussion, I refer to these three counterfactuals as the main reforms.

For the fourth policy experiments, I experiment with the progressivity of the property tax. I introduce progressive property taxes, without owner-occupied exemption. I consider two versions of the property tax schedule, one more and one less progressive. For each counterfactual I present the results with tax revenue neutrality. Tax revenue neutrality is achieved by changing the level of taxation λ_0 ensuring that the absolute tax revenue remains the same, i.e. the increase in tax revenues from property is given back to the household by lowering taxes on income.

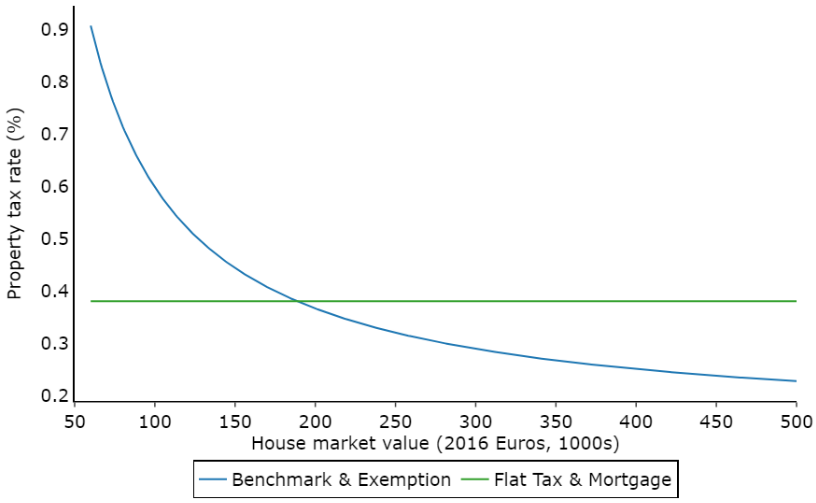
4.1 Main Reforms

The effective property tax rate applied in these counterfactuals can be seen in Figure 7. The effective property taxes are regressive in the benchmark and the first counterfactual, denoted as Exemption, but flat for the second and third counterfactuals, denoted as Flat Tax and Mortgage respectively. However, due to the presence of the owner-occupied exemption in the benchmark, the regressivity of the property tax rate does not play a significant role. Meanwhile, in the first counterfactual, where the exemption is removed, the regressive tax rate encourages the purchase of larger properties. Finally, when moving to the counterfactuals with a flat tax, the second and third, properties with a low market value (less than 200 thousand euros) face a lower effective property tax rate, while houses with a larger market value face a higher one, compared to the first counterfactual.

Table 3 compares the several outcomes of interest between the benchmark and the three counterfactuals. Comparing the benchmark to the first counterfactual, column titled Exemption, we observe that the tax revenues from property increase by 0.89 percentage points, approximately 14 billion euros. However, as expected, the unit house price and the homeownership rate drop, by 2 percent and 2.6 percentage points, respectively. The removal of the owner-occupied exemption increases the user cost of owning a house and reduces homeownership. The regressive property taxation schedule that applies makes the user cost increase relatively more for properties with lower market values.[20]

[20] An interesting aspect worth remarking is that the model predicts an increase in property tax revenue similar to the one obtained through the back-end calculations from cadastral rents discussed in the previous section.

Figure 7: Effective Property Tax Rate in Counterfactuals



The result for the second experiment can be seen in the fourth column of Table 3, Flat Tax. Whereas property tax revenue as % of GDP is comparable to the first counterfactual (reaching 0.9 %), homeownership rate actually increases by 2.6 percentage points compared to the benchmark. Nonetheless, these results are accompanied by a larger decrease in the house unit prices, which drop by 4.4 percent. This counterfactual shows that if the owner-occupied exemption is accompanied by the adjustment of the tax base to market values, i.e. a flat property tax rate, homeownership rate can actually increase. The main reasons for this results, which will be analyzed below, are the changes in house prices and the changes in effective property tax rates. The lower house price enables households in lower wealth deciles to increase their homeownership. Meanwhile, the flat property tax rate encourages households to live in smaller houses, reducing the demand for house units.

Lastly, in the third counterfactual, column Net of Mortgage, the drop in price is smaller than the Flat Tax counterfactual, 4.1 percent, and homeownership is even higher, reaching 68.8% of households. As expected, the percentage of homeowners with an outstanding mortgage increases: 1 percentage points higher than the benchmark, and 1.5 percentage points higher than the Flat Tax counterfactual. The increases in homeownership and mortgage uptake compared to the second counterfactuals are driven by households in the working age groups. It must be noted that given the low use of mortgages, the Italian context might not be the best one to analyze the potential of this policy. In a setting with a higher mortgage uptake the results could be even more striking. Finally, across the three counterfactual we observe very small changes in the Gini coefficients for wealth.

Table 3: Main Property Taxation Reforms

	Bench	Exemption	Flat Tax	Net of Mortgage
Price	1.0	0.98	0.956	0.959
Homeownership Rate	65.0	62.4	67.6	68.8
Wealth	194.4	193.3	195.7	195.3
Real Estate Wealth	115.5	111.9	112.0	114.1
% of Owner with Mortgage	12.3	11.4	11.8	13.3
Tax Revenue as % of GDP	0.03	0.92	0.9	0.89
Gini (Wealth)	0.486	0.49	0.483	0.483

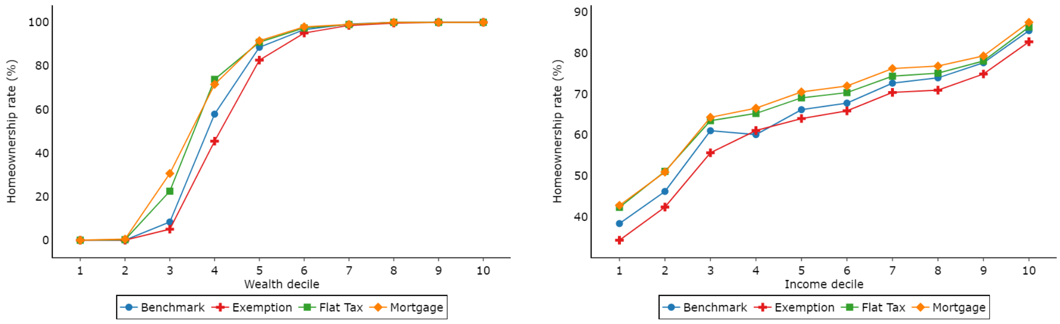
Notes: The table compares the main outcomes of interest across the benchmark and the first two counterfactuals. The counterfactual are tax revenue neutral, obtained by changing the level of the income taxes. Counterfactual 1 (Exemption) is the removal of the owner-occupied house exemption. Counterfactual 2 (Flat Tax) is the removal of the owner-occupied house exemption and the adjustment of the cadastral value to match the market value. Counterfactual 3 (Net of Mortgage) adds to Flat Tax the fact that taxes apply on house value net of mortgages.

What are the mechanisms for different effects on homeownership in the experiments? Figure 8 shows the homeownership rate by wealth and decile across the three counterfactuals. Regarding wealth, (Figure 8a), homeownership rate for the top 4 deciles is approximately unchanged across the experiments. With only the owner-occupied exemption, the homeownership rate among households between the third and fifth wealth decile declines sharply, as the higher property taxes made housing investment less attractive, especially for cheaper houses. Instead, by comparing the first to the second and third counterfactuals, we can observe that as house prices decrease poorer households between the third and fifth wealth decile can afford to become homeowners.

Regarding homeownership along the income distribution, (Figure 8b), and across age groups, Figure 9, the changes in homeownership are spread more equally across the entire distribution. In the first counterfactuals, homeownership drops for households in all income deciles and age groups, while for the second and third, it increases.

Table 4 shows the distribution of house value. Each row shows the percentage of

Figure 8: Homeownership Rate by Deciles



(a) Wealth deciles **(b)** Income deciles

Notes: The figure compares homeownership rate by wealth and income decile across the benchmark and the first three counterfactuals.

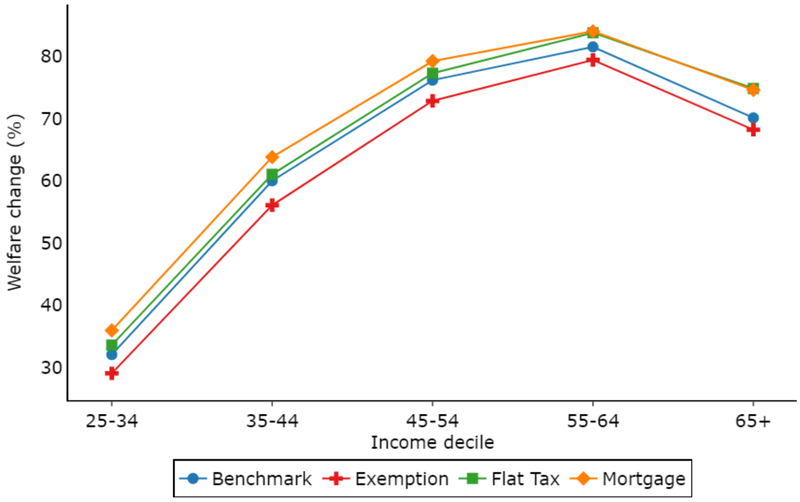
household among homeowners who have a house valued within the range highlighted in the first column (in thousands of euros). Compared to the benchmark, in the first counterfactual we see an increase in the percentage of homeowners with houses valued at 200 Thousands euros or more. This is mainly driven by the regressivity of the property tax schedule that encourages the purchase of larger house. However, as we move to a flat property tax in the second and third counterfactual, the share of homeowners with houses with a market value above 200 thousand euros decrease sharply.

Table 4: Distribution of House Values

Range	Bench	Exemption	Flat Tax	Net of Mortgage
0-100	4.7	3.6	6.5	6.4
100-200	65.1	64.1	70.4	70.9
200-300	24.8	27.5	20.4	20.0
300-400	4.9	4.0	2.6	2.5
400-500	0.5	0.6	0.3	0.2

Notes: The table compares the percentage of homeowners that have a house with a value with the range highlighted in teh first column, in thousand of euros across the benchmark and the first three counterfactuals.

Figure 9: Homeownership Rate by Age Groups



Notes: The figure compares homeownership rate by age group across the benchmark and the first three counterfactuals.

4.2 Progressive Property Taxation

For the next counterfactual, I introduce progressive property taxes that apply to the entire housing unit owned by the household. I do two versions of this experiment, with the first one being more progressive, and the second one less. I model the property taxes with the same two parameter functional form used for income taxation:

$$\bar{\mathcal{T}}(ph) = 1 - \bar{\lambda}_0 ph^{-\bar{\lambda}_1},$$

where ph is the market value of the property being taxed, $\bar{\lambda}_0$ is the level of the property tax function, and $\bar{\lambda}_1$ is the progressivity parameter. Total property taxes due are given by $ph \times \bar{\mathcal{T}}(ph)$.

I assign values to the two parameters of the property tax function by exploiting the definition of a progressivity metric called progressivity tax wedge:

$$PW(v_1, v_2) = 1 - \frac{1 - \bar{\mathcal{T}}(v_2)}{1 - \bar{\mathcal{T}}(v_1)} = 1 - \left(\frac{v_1}{v_2}\right)^{\bar{\lambda}_1},$$

with v_1 and v_2 being arbitrary house values and $v_1 < v_2$ (Guvenen et al., 2014, Holter et al., 2019). The progressivity tax wedge gives a measure of how strongly the tax rate changes between v_1 and v_2.

For the first version of the counterfactual I choose v_1 to be approximately the median house value in thousands of euros in the benchmark economy, $v_1 = 180$, and v_2 to be the maximum house value, $v_2 = 500$. Then, I set the property tax rate for the median house to be $\bar{\mathcal{T}}(v_1) = 0.38\%$, in line with the national property tax rate adjusted by the average market to cadastral ratio. Meanwhile, I set the property tax rate of the largest house to be $\bar{\mathcal{T}}(v_2) = 1\%$. This gives a progressivity parameter $\bar{\lambda}_1 = 0.0061$.

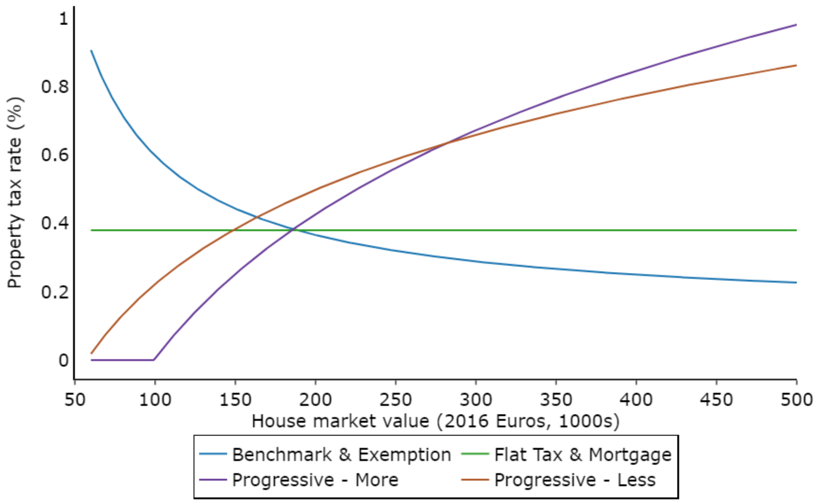
Given the chosen property tax rates for v_1 and v_2, and the progressivity parameter, the level parameter has to be $\bar{\lambda}_0 = 1.0727$ for $\bar{\mathcal{T}}(v_1) = 0.38\%$. As discussed above, by using this two parameter functional form, negative tax rates occur for low values. I have set these to 0 in order to avoid paying out subsidies.

For the less progressive version I reduce the progressivity of the property taxation function. I do this by lowering the progressivity parameter from $\bar{\lambda}_1 = 0.0061$ to $\bar{\lambda}_1 = 0.0040$, and changing the level parameter to make sure that the median house pays the same amount of property tax rate, obtaining $\bar{\lambda}_0 = 1.0456$. As it can be seen in Figure 10, which represents the property tax rates in the benchmark and the four counterfactuals, the effective property tax rate function for the less progressive version of this counterfactual is a clockwise rotation pinned on the median value of the effective property tax rate function of the more progressive version.

Table 5 shows the main outcomes of interest for the two progressive property taxation counterfactuals. These amplify the main conclusions found in the second and third counterfactual. As property tax rate on small houses reduces even further, while tax rate on large houses increases, the demand for large houses decreases pushing down the per unit price, and more households can afford small houses. Indeed, we can see that in both in the more progressive and less progressive counterfactual, the per unit price falls drastically, by approximately 10 percent, and overall homeownership increases above 70%. The increase in property tax revenues in the more progressive version of the counterfactual is even higher than the one observed in the first three (0.99% of GDP, compared to approximately 0.9% of GDP in the first three counterfactuals).

By looking at homeownership by wealth decile in Figure 11a we can see a significant increase in homeownership rate across the third to fifth wealth decile. This increase is

Figure 10: Property Tax Rate in Benchmark and Counterfactuals



Notes: The figure depicts the property tax rate for different market value properties for the benchmark and the four counterfactuals.

larger than the one obtained in the second and third counterfactuals analyzed above. For the third decile homeownership rate passes from 10% to more than 40%, while for the fourth decile it goes from 58% to 88% in the first version and 77% in the second one. Regarding the income distribution, we can observe that the progressive property taxes increase homeownership especially among households in the lowest deciles.

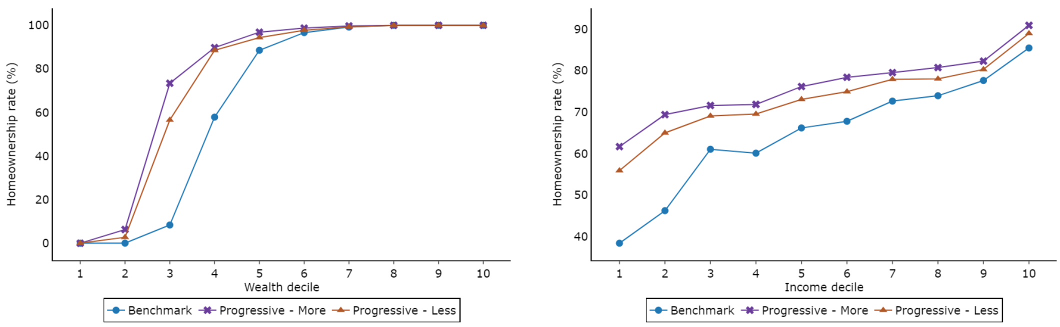
These two policy experiments show that a progressive property taxation system has the potential to generate large government revenues, and to increase homeownership rates. Nonetheless, a system that is *too* progressive can lead to a lower increase in property tax revenue. Furthermore, house prices decrease a great deal as demand for large houses composed of many housing units falls. Finally, the overall level of wealth inequality measured by the Gini coefficient drops substantially with progressive property taxes.

Table 5: Progressive Property Taxes Reform

	Bench	More Progressive	Less Progressive
Price	1.0	0.901	0.913
Homeownership Rate	65.0	76.3	73.3
Wealth	194.4	199.4	198.3
Real Estate Wealth	115.5	108.9	108.1
% of Owner with Mortgage	12.3	12.6	11.9
Tax Revenue as % of GDP	0.03	0.74	0.99
Gini (Wealth)	0.486	0.47	0.475

Notes: The table compares the main outcomes of interest across the benchmark and the last two counterfactuals. The counterfactual are tax revenue neutral, obtained by changing the level of the income taxes. Both version tax remove the owner-occupied exemption. The first version of the Counterfactual 4 uses a more progressive property tax rate. The second version of Counterfactual 4 uses a less progressive property tax rate.

Figure 11: Homeownership Rate by Deciles



(a) Wealth deciles

(b) Income deciles

Notes: The figure compares homeownership rate by wealth and income decile across the benchmark and the progressive property taxation counterfactuals.

4.3 Overall Tax Progressivity

The model features two types of taxes: taxes on income and taxes on properties. In the benchmark economy, taxes on properties are negligible, hence the overall tax system is progressive, due to the progressivity of the income taxation. This can be seen in Figure 12, which shows total taxes paid as percentage of disposable income by income decile. Households in the first income decile pay around 25% of their disposable income on taxes while households in the last income decile pay around 44%.

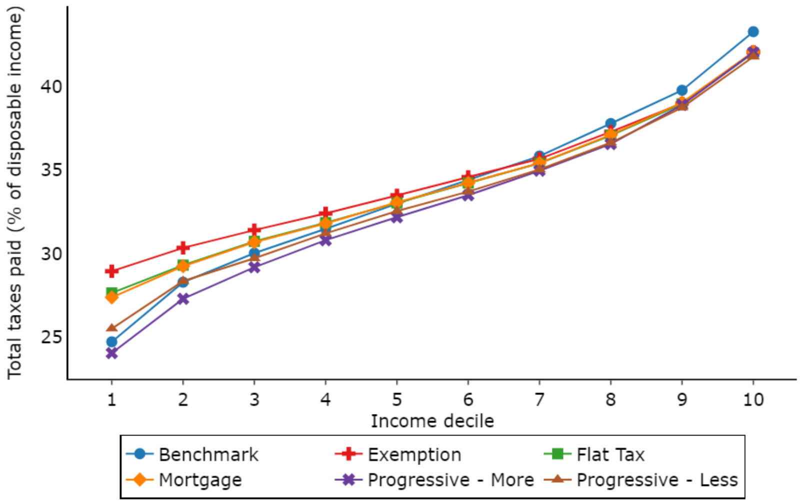
By taxing properties in the counterfactuals overall taxes become less progressive, except for the experiment with the more progressive property tax rate. This can be seen from Figure 12. Compared to the benchmark, households in the low income decile are paying a larger percentage of their disposable income, while households in higher income deciles are paying a lower percentage. Two aspects explain this result. First, for a given property, the increase in property taxes due to the policies are a higher burden on the disposable income of low income household compared to the high income ones. Second, the method used to obtain tax revenue neutrality, i.e. a downward shift of the marginal income tax rate, benefits households across all income levels, and especially higher income households.

A different method of achieving revenue neutrality could avoid a less progressive taxation system. For instance, rather than lowering the income taxation level, a transfer could be given to households. The size of this transfer could depend on the income decile. Alternatively, by changing the progressivity parameter of the income tax rather than the level, it is possible to achieve the desired level of tax progressivity.

5 Welfare

Finally, I compare welfare implications of the policies. Welfare changes are defined by consumption equivalent variation from the benchmark economy. I compare welfare changes in the long run, i.e. across steady states, and in the short run. For the long run, I compare welfare changes for newborns after drawing the first income realization. This is done in order to show how welfare changes are heterogeneous across income groups. For the short run, I compute the welfare change for households that are alive at the time

Figure 12: Progressivity of Taxation



Notes: The figure compares the total taxes paid as a percentage of household disposable income by income decile in the benchmark and five counterfactual policies.

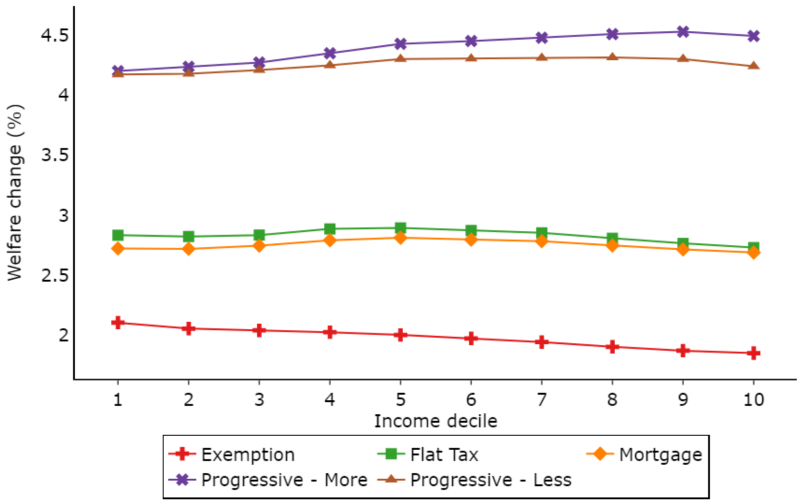
of the reform. To do this, I obtain the transition dynamics from the benchmark to the new steady state. The welfare change for counterfactual c is given by:

$$Welfare\ Change_i^c = 100 \times \left(\left(\frac{V^c(j,i,a,h)_t}{V^b(j,i,a,h)} \right)^{1/\zeta(1-\sigma)} - 1 \right), \tag{13}$$

where $V^c(j,i,a,h)_t$ is the value function, as defined in Equation (3), obtained in the counterfactual c at time $t \in [0,1,...,\infty)$, where the reform took place in time $t = 1$ and $t = \infty$ represents the new steady state. Instead, $V^b()$ is the value function obtained in the benchmark economy. Finally, ζ and σ are the household's expenditure share of consumption and the degree of relative risk aversion, respectively. For the long run comparison, I focus on a newborn household ($j = 1$), that had income realization i, and has no wealth nor housing ($a = h = 0$) in the new steady-state ($t = \infty$). For the short-run analysis, I compare the value function of all households across the state-space between the benchmark and the year of the reform ($t = 1$).

Figure 13 shows the long run welfare changes across counterfactuals. For all counterfactuals welfare improves: from around 1.97% improvement in the first counterfactual to 3.4% in the fourth counterfactual. Whereas the welfare changes are positive across

Figure 13: Welfare Changes Across Counterfactuals



Notes: The figure shows the long run welfare change between the benchmark and the different counterfactuals.

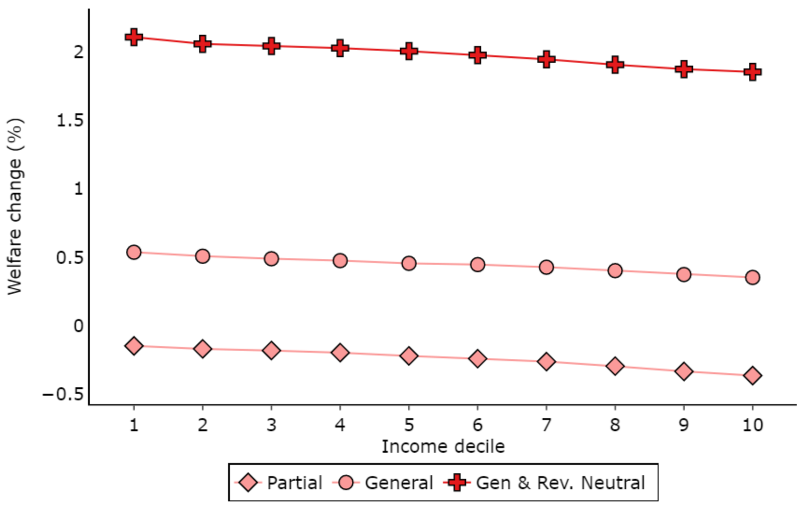
all income deciles, newborns that drew a higher income realization have a lower welfare gains, except for the more progressive version of the fourth counterfactual. It is not straight forward that increasing property taxation, hence the user cost of housing, should lead to higher welfare. This is particularly true considering that in the model labour is inelastic. In order to analyze this aspect further, one can decompose the different effects of changes in housing taxation on welfare.

The policy experiments affect welfare through three different channels: homeownership rate, house prices, and income taxation. Firstly, increasing property taxes increases the user cost of housing and hence discourages homeownership. A lower homeownership affects welfare in two ways. First, it increases the monitoring costs that households need to pay to the real estate agents. Second, it lowers the amount of transaction costs due to housing purchases.

The second channel is through changes in house prices. Lower house prices reduce the cost of housing services and hence increase consumption. Furthermore, considering the fact that there is the down-payment constraint and the that there is a minimum house size that can be purchased, lower prices enable poorer households who were previously constraint to purchase a house. Finally, as all the counterfactuals are tax revenue neutral, there is a shift from taxing income to taxing houses.

In order to measure the importance of these different channels in affecting welfare, I compare the benchmark to the counterfactuals across three different steady-state equilibria. The first comparison is with partial equilibrium. Thus, the counterfactual policy applies, but house prices and rents are not changed. The second comparison is with general equilibrium, i.e. house prices can change, but without tax revenue neutrality. Finally, the benchmark is compared to the counterfactual in general equilibrium with tax revenue neutrality. This last equilibria is the one adopted for the results analyzed in previous sections. Figures 14, show the welfare comparison across the different equilibrium for the first counterfactual, Exemption. A similar picture emerges from the other counterfactuals.

Figure 14: Welfare Changes across Different Steady-States - Exemption



Notes: The figure shows the long run welfare change between the benchmark and the first counterfactual (Exemption) across different steady state. The partial steady state occurs when the reform takes places, but prices do not adjust. The General steady state occurs when prices change, but the policy is not revenue neutral. Finally, the General and Revenue Neutral steady state occurs when prices changes and the policy is revenue neutral.

From Figure 14 it is possible to see that when only the the owner-occupied exemption is removed, and house prices do not adjust, the welfare in the new steady-state drops. This is expected, as the counterfactual policy increases the user cost of owning a house.

Furthermore, we can see that the welfare drop is higher for the households that are born in high income deciles, as they are more likely to buy larger houses and hence pay a larger property tax. However, when we move to the second steady-state setting, where house prices can adjust, we observe that welfare improves for all income deciles. Finally, in the last setting, with both changes in prices and tax revenue neutrality, welfare improves even more, as households have higher disposable incomes.

These result suggest that the long run welfare improvement of the counterfactual is mainly driven by the reduction in equilibrium prices. Lower house prices reduce housing services cost and allow more households, especially the low wealth ones, to purchase their house and avoid paying the monitoring costs.

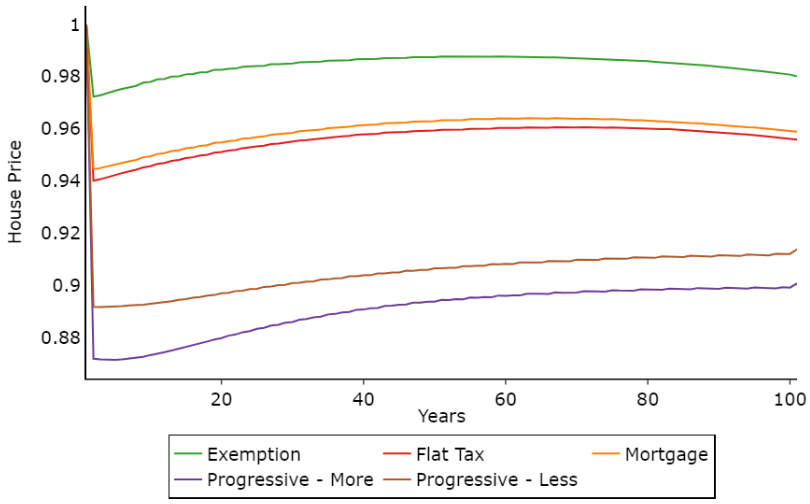
The long run welfare improvements are not mirrored in the short run analysis. Table 6 shows the short run welfare change and the percentage of winners from the reform across age groups for each counterfactual. Overall, the welfare of the households who are alive at the time of the reform drops by around 3%. The table shows the heterogenous effects of the reform across age groups: younger cohorts benefits, while older ones lose. This can also be seen from the percentage of winners. Whereas across the entire population the winners are less than a quarter, among the youngest cohorts is more than two thirds. These results are given by the large initial drop of house prices, which lowers the wealth of households that own properties - Figure 15.

Table 6: Short Run Welfare Analysis

Counterfactual		All	25-34	35-44	45-54	55-64	65+
Exemption	Welfare Change	-3.3	0.2	-1.0	-2.4	-4.3	-6.2
	% of Winners	14.9	67.1	21.7	0.9	0.0	0.0
Flat Tax	Welfare Change	-3.2	0.8	-0.8	-2.4	-4.4	-6.4
	% of Winners	19.6	68.0	39.6	4.5	0.0	2.7
Mortgage	Welfare Change	-3.3	0.8	-0.8	-2.4	-4.4	-6.4
	% of Winners	18.4	68.1	39.4	3.0	0.0	0.0
Progressive More	Welfare Change	-3.1	1.9	-0.3	-2.4	-4.7	-6.6
	% of Winners	24.3	71.4	40.1	23.8	1.6	4.4
Progressive Less	Welfare Change	-3.2	1.5	-0.5	-2.5	-4.7	-6.6
	% of Winners	23.5	68.9	40.0	23.1	1.0	3.9

Notes: The table compares the welfare change as defined in Equation (13) between the benchmark economy and the value function immediately after the reform takes place.

Figure 15: House Prices Along the Transition



Notes: The figure shows the house unit prices for the different counterfactuals along the transition between steady states.

6 Conclusions

Property taxes do not apply to owner-occupied houses in many countries. In Italy, as a result of this exemption, the government forgoes the opportunity of raising tax revenues from approximately 70% of households. Given the large amount of households that live in their own home, any reform that increases taxes is perceived negatively. A second issue regarding property taxation in the Italian setting is the use of outdated cadastral values that do not match the market values of properties. This generates an inequitable taxing system where properties with the same market value can pay different amounts of taxes. More importantly, I show that more valuable houses tend to have a relatively lower cadastral value, implying that houses with high market value pay a lower effective property tax rate than smaller houses. This creates a regressive property tax system.

In this paper I quantitatively assess the effects of removing the owner-occupied exemption on the homeownership structure and the government tax revenues. Furthermore, I study the effects of complementing this policy with the adjustment of the cadastral values to the market values. Finally, I analyse alternative property taxation systems such as taxing houses net of mortgage and through the use of a progressive property taxation.

I find that the government could increase tax revenue as percentage of GDP by 0.89 percentage point by fully removing the owner-occupied exemption. Furthermore, the government can compensate for the reduction in homeownership that this policy would entail by combining it with the adjustment of the cadastral values to the market values. This result is explained by the fact that more households purchase smaller houses as the tax rate on these is reduced thanks to the cadastral value adjustment. Furthermore, I show that with progressive property taxation system homeownership rate increases, yet house prices fall significantly. The higher taxes of large houses reduces demand of house units, dropping the house price. This drop in price, together with the lower taxes on small houses, enables households in the bottom deciles of the wealth distribution to purchase a small house, boosting the overall homeownership rate. Finally, I show that these counterfactual policies are welfare improving in the long run, but in the short run there are heteregenous results. Young households who are alive at the time of reform benefit, while the welfare of older ones falls.

The paper abstracts from several important features. Firstly, the model treats the entire Italian housing market as a single market, with no regional or urban-rural separation. Adding this aspect would lead to a much more complex model, but it could be used to analyze the migration trends present in Italy. Finally, I do not discuss the political feasibility of the policies I analyze. As shown by the 2012 and 2016 reforms, removing the owner-occupied exemption has very large electoral costs and any government would find it hard to justify this policy. Meanwhile, the adjustment of the cadastral values has been discussed for more than ten years with no tangible change, due to the large administrative costs it involves.

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Appendix

A Italian Setting

For most Italian households, housing is the most important source of wealth. According to the Italian Survey on Household Income and Wealth (SHIW), for 67.6% of households real estate is the main wealth item in their portfolio, while for 48.6% of households, it is the only asset.[21] Table A1 shows, there are significant differences in real estate holding across the wealth and income distribution. Only 1.9% of households in the lowest wealth quintile own any real estate, compared to more than 97% of households in the top three quintiles. These differences are significantly less pronounced throughout the income quintiles. 40.1% of household in the lowest income quintile own real estates, compared to 93.6% in the highest quintile.

A.1 Mortgages and Transfers

Despite the high homeownership in Italy, mortgages play a relatively minor role. Only 12.4% of homeowners have an outstanding mortgage. Also in this case there are differences across the wealth distribution. For instance, 86.3% of homeowners in the lowest wealth quintiles have an outstanding mortgage. Yet, as the share of homeowners in this quintile is small, it turns out that only 1% of total households in the lowest wealth quintile have an outstanding mortgage. Meanwhile, the share of homeowners with an outstanding mortgage in the highest quintiles a great deal smaller, only 8%.

There are several reasons for the low mortgage uptake in Italy. Historically, credit was rationed by law until the 80s. Even after the financial liberalization, banks continued to request a high down payment since debt recovery is rather difficult due to slow and uncertain judicial procedures (Villosio, 1995, Chiuri and Jappelli, 2003). Furthermore, family transfers, bequests, and longer periods of co-living with older generations ensure

[21] Data for 2016. The Appendix B provides further information on data used. Real estate is classified as the main asset if the real estate value is larger than the combination of financial assets and real assets excluding real estate. Real estate is classified as only asset if the real estate value is positive and the value of securities plus business assets is 0.

Table A1: Share of Real Estate in Total Wealth

Wealth Quintile	Real Estate Assets (%): Any	Mainly	Only	Real Estate Value (2016 Euros)	Outstanding Mortgage (%)
1	1.9	1.7	1.8	41355	86.3
2	55.4	53.6	51.1	72216	25.8
3	97.4	95.8	81.5	123657	12.8
4	99.6	97.0	67.4	202791	8.8
5	99.4	89.9	41.3	506922	8.0
Total	70.7	67.6	48.6	244975	12.4
Income Quintile	**Real Estate Assets (%): Any**	**Mainly**	**Only**	**Real Estate Value (2016 Euros)**	**Outstanding Mortgage (%)**
1	40.1	39.1	35.2	112476	6.8
2	58.1	56.8	49.3	135532	8.7
3	77.7	74.7	63.5	186815	9.1
4	84.1	81.3	53.4	250828	13.1
5	93.6	86.1	41.7	412793	19.3
Total	70.7	67.6	48.6	244975	12.4

Notes: The table shows the distribution of assets of households across wealth and income quintiles. The first columns shows the percentage of households that have any real estate assets. The second columns shows the percentage of households for which real estate is the main asset. The third column shows the percentage of households for which real estate is the only asset. The value column shows the average value of the real estate assets. The last column shows the percentage of households with a positive real estate assets that have mortgages. Source: SHIW, 2016 wave.

that younger household can purchase a home without collecting debt (Guiso and Jappelli, 2002, Bernardi and Poggio, 2004).

Approximately a third of homeowners acquired their main residence through inheritance or gifts (Table A3). Further insights on the importance of transfers for Italian households can be found in the 2002 wave of the SHIW, as only this wave contains complete information on all types of transfers. Figures A1 and A2 show information on transfers obtained by households whose head is between 25 and 44 years of age across wealth and income groups respectively.[22] The left panel shows the fraction of households in a wealth or income group that obtained a transfer, while the right panel shows the average value of the transfer in thousands of 2016 euros.

[22] As only half of the 2002 wave respondents were asked to participate in the transfer module, the sample for the analysis is small. Thus, rather than using quintiles, I use three larger groups: Low (first three decile), Medium (fourth to seventh decile), and High (eight to last decile).

Table A2: Importance of Main Property

Wealth Quintile	Main Value (2016 Euros)	as % of Wealth Owners	as % of Wealth All
1	56773	381.5	4.3
2	69848	143.4	76.4
3	118678	93.8	90.6
4	185975	83.2	82.7
5	355984	64.2	63.6
Total	197327	90.9	63.5

Notes: The table shows the information on the value of the main property owned by household across wealth quintiles. Main property refers to the property where the households live. The first columns shows the average value of the main property (among owners of properties). The second column shows the value of the main in % of total wealth (that includes liabilities) among owners. The last column shows the same information, but across the entire population in the wealth quintile. Source: SHIW, 2016 wave.

Across income, around 20% of households in the first income group obtained a transfer, while this number is around 35% for households in the top income group. Furthermore, the average value of a transfer increases across groups. The average value of a transfer to households in the first group is approximately 100.000 euros, while it is around 200.000 euros for households in the last group. The difference is more pronounced across wealth groups. Less than 5% of households in the first wealth group obtained a transfer, while more than 40% among the third wealth group.

Given their importance, intergenerational transfers and gifts have contributed significantly to the high homeownership rate. Another contributor have been housing and fiscal policies favorable for homeownership (Bernardi and Poggio, 2004).

A.2 Taxes on property

The property tax rate in Italy is set by the national government, but municipalities are allowed to increase or decrease it within certain bounds.[23] The national tax rate

[23]Municipalities can adjust the national property tax rate between 0.46% and 1.06%. For more information refer to the Appendix C and Bises and Scialà (2014).

Table A3: Real Estate Inheritance and Gifts

Wealth Quintile	Inherited Main	Inherited or Gifted Main	Inherited or Gifted All
1	2.1	15.8	23.8
2	33.2	38.1	40.0
3	32.8	38.5	41.0
4	28.4	33.9	38.4
5	27.8	33.1	49.2
Total	30.1	35.5	42.3

Notes: The table shows the mode of acquisition of properties across wealth quintiles. Main property refers to the property where the households live. All refers to any properties the household has. The first columns shows the percentage of households that have acquired their main property through inheritance. The second columns includes also gifts. The last column includes any properties. Source: SHIW, 2016 wave.

is 0.76%.[24] This rate is applied to the registered cadastral value of the property. As I discuss below, these cadastral values can differ from market values. Furthermore, owner-occupied houses are exempt from the property tax. Figure A3 shows the total revenues from property taxes (on land, buildings and other structures), as absolute values (right axis) and as a percentage of GDP (left axis). Since 2012, the government has collected around 1% of GDP, comparable to other advanced economies.[25] Before the 2012 reform, tax collection was about half of what it is today.

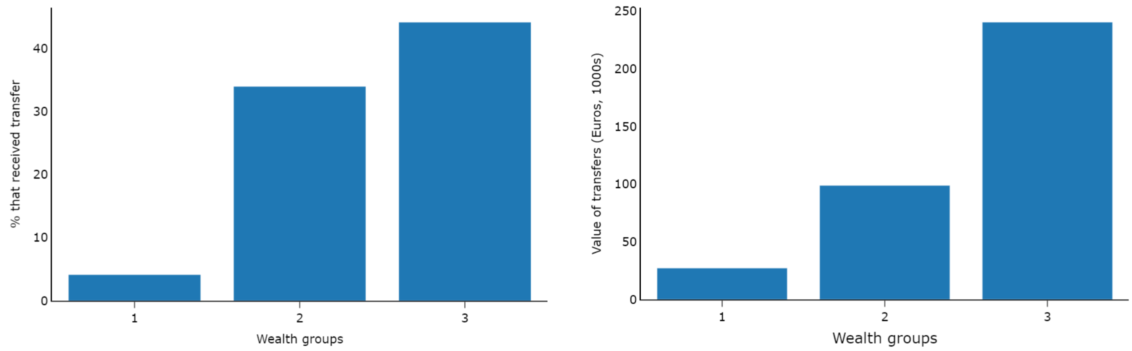
A.2.1 Owner-Occupied exemption

Until 2008, property taxes applied also to owner-occupied houses, albeit some reductions were present. Full owner-occupied exemption was introduced in 2008. This exemption implied that households that owned property would pay taxes only on the houses that they rent, used for production purposes, or which they owned but did not live in, e.g. summer houses. In 2012, the owner-occupied exemption was removed in order to increase tax revenues. The increase in government revenue can be clearly seen in Figure A3. However, deductions for owner-occupied houses were present also in this case, and the property tax rate applied to these residences was lower, 0.4% rather than

[24] From 2021 it has been increased to 0.86%

[25] Spain also collects around 1% of GDP. France and the United Kingdom collect more, 2.7% and 3% respectively. Germany collects less, 0.5%. The OECD average is around 1% of GDP (2016)

Figure A1: Transfers by Wealth Groups



(a) Fractions who received transfers

(b) Value of transfers

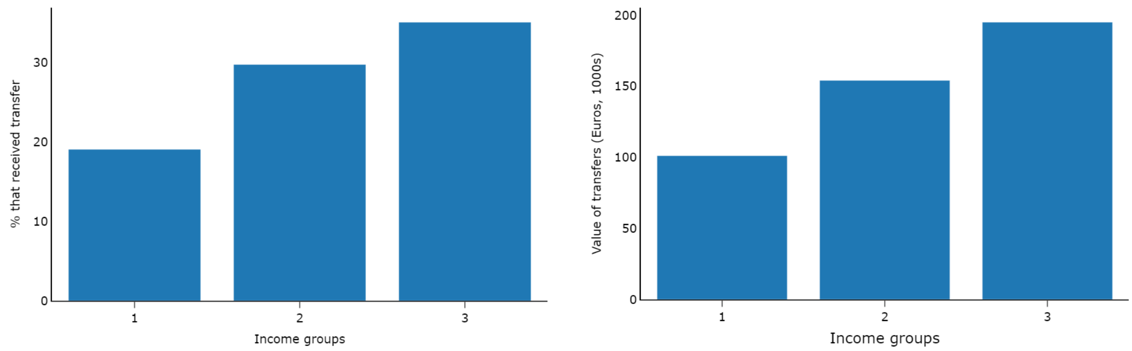
Notes: The figure shows the transfers received by household whose household head is between the ages of 25 and 44 across wealth groups. The left panel shows the fraction, while the one on the right on the mean value in 2016 thousands of euros, both of the transfer and across the entire group population. Source: SHIW, 2002 wave.

0.76%. These conditions exempted completely around 4 million households (Messina and Savegnago, 2015). Nonetheless, following widespread discontent with the policy and political debate, from 2016 the owner-occupied exemption was fully reinstated. With such a large percentage of owner-occupied houses, it does not come as a surprise that property taxes are a highly debated political topic (Alesina and Paradisi, 2017).

Figure A3 shows that the 2008 reform that eliminated the exemption reduced government revenues by 3 billion euros.[26] The reintroduction of the exemption in 2016 had similar consequences, with a fall in revenue from 25 billion to 21 billion. These numbers imply that the owner-occupied exemption increases government revenues by 3 to 4 billion. While these changes are relevant, they could be much larger if the removal of the owner-occupied exemption was carried out in full and no deductions were granted. From some back-end calculations that I discuss in the Appendix C, I estimate that the increase in government revenue could be 14 billion euros.

[26]More precisely, in 2007, 5.5 of the 12 billion euros of revenues were from residential property, while the rest were revenues from properties used for production purposes. The first component fell by 3 billion in 2008 due to the owner-occupied exemption (Agnoletti et al., 2020).

Figure A2: Transfers by Income Groups



(a) Fractions who received transfers

(b) Value of transfers

Notes: The figure shows transfers received by household whose household head is between the ages of 25 and 44 across income groups. The left panel shows the fraction, while the one on the right on the mean value in 2016 thousands of euros, both of the transfer and across the entire group population. Source: SHIW, 2002 wave.

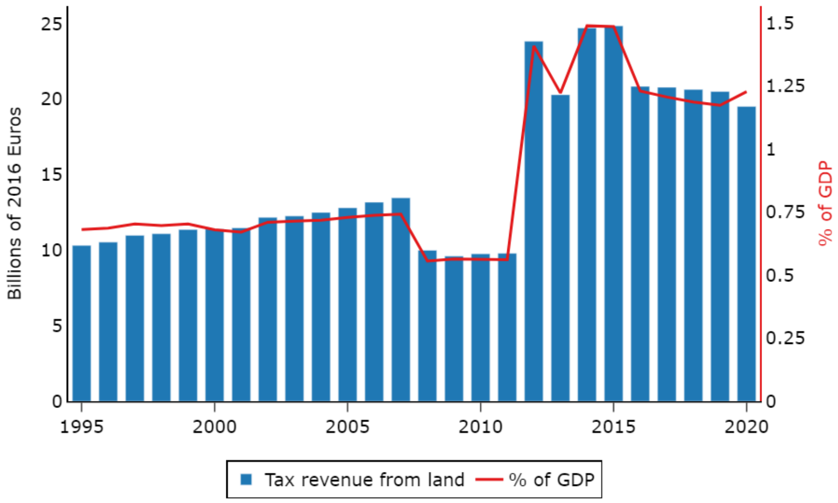
A.2.2 Cadastral and Market Values

The second aspect of the 2012 reform was an increase of the cadastral values. The cadastral value is an artificial construction, often not related to the current market value. The Italian tax authority assigns to each property a cadastral rent that is determined based on the size of the house, the number of rooms, and the property's location. The current cadastral rents are based on rents that could be obtained in the end of the 80s (Bordignon et al., 2017). To calculate the cadastral value, the rent is first multiplied by 1.05, a one-time ad-hoc adjustment introduced in 1997. Then, the adjusted rent is multiplied by a cadastral multiplier. The 2012 reform increased the multiplier for residential property from 100 to 160.[27] As a result, even if the owner-occupied exemption was reintroduced in 2016, the tax revenue continued to be higher after the 2012 reform due to this change in the tax base - Figure A3.

The fact that the cadastral rent is not updated automatically and the cadastral multipliers are applied uniformly for all the houses throughout the country leads to two issues. First, the cadastral value does not reflect current market values. The Ministry of

[27] Appendix C provides further information on the changes of the 2012 reform.

Figure A3: Total Revenues from Taxes on Land, Buildings and Other Structures



Notes: The figure shows the total tax revenue from land, buildings and other structures collected by the Italian government between 1995 and 2019. The bars represent the amount collected in current euros, and refer to the left vertical axis. The line represents the amount collected as percentage of current GDP, and refer to the right vertical axis. Source: OECD. Refer to Appendix C for further information.

Finance (MEF) and the Italian tax agency estimated that even after the 2012 increase of cadastral multiplier, the average market value is around twice the cadastral value (Festa and Erika, 2014, Dipartimento delle Finanze, 2020). Second, the cadastral value does not capture local variations in prices over time (Guerrieri, 2013). This could lead to the situation where two houses that have been assigned the same cadastral value, and hence pay the same amount of property taxes, have different market values.

In order to provide evidence on the difference and relationship between cadastral and market values, I combine three different sources of data for 2016, all obtained form the Italian tax agency.[28] The first one is the Real Estate Market Observatory (OMI) dataset. This dataset provides real estate quotes for micro-areas for the entirety of Italy.[29] I obtained an average price per municipality through a weighted mean of the average price per micro-area, with the weights given by the relative geographic size of the micro-area. As the prices provided in this dataset are per square meters, I used a

[28]The Appendix D provides further information on the data used and summary statistics.

[29]These micro-areas, called *Zone OMI*, are constructed to be homogeneous in terms of house prices.

second dataset on cadastral estimates to obtain the average square meters of a house. However, this information is available only at the provincial level. Thus, each municipality within a province is assumed to have the same average square meters. Finally, I used data on cadastral rent by municipality to obtain the average cadastral value by municipality by multiplying the cadastral rents by 1.05 and then 160.

To display the difference and the relationship between the market value (MV) and the cadastral value (CV) for each municipality i, I compute the ratio $Ratio_i = MV_i/CV_i$. A value higher than one implies that the market value is not being fully captured by the cadastral value. As the ratio increases, the cadastral value is capturing a lower part of the actual value. On the other hand, a ratio less than one implies that taxable base is higher than the actual value of the asset.

Figure A4 shows the *Ratio* across Italy. Municipalities in red have a ratio that is below one. Hence, in these municipalities the taxable value is larger than the actual value of the property. A darker blue implies a higher ratio, i.e. a lower capability of the taxable value to capture the actual value. Interestingly, the North-South divide that characterizes Italy across many dimensions is not present. Indeed, one of the main determinants of the ratio is the change in local house prices in the last 30 years (Guerrieri, 2013). As the cadastral rents are based on market values of the 80s, localities that faced a large increase in house prices have a high ratio, while localities with a low or negative price growth can have ratios even below one. In the Appendix D I provide some evidence that higher ratios are found in municipalities that are touristic and have higher income.[30]

Finally, I regress the average market value on the average cadastral value at the municipal level. Equation (14), which shows the obtained estimates, summarises the issues discussed. First, the cadastral value does not capture the current market values of properties. Second, as the cadastral value increases slower than the market value, houses with a higher market value have a relatively lower cadastral value and higher ratio. Hence, the effective property tax rate, as defined in Equation (12), decreases with the market value of the houses. This leads to a regressive property tax.[31]

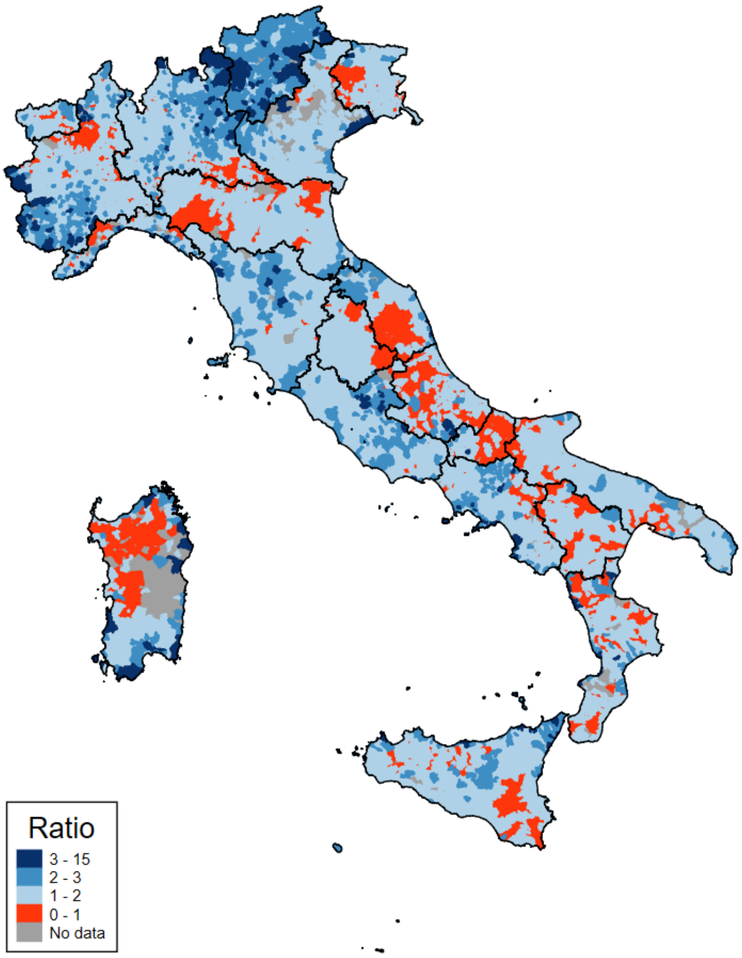
[30]Figure A4 provides some visual evidence of this: municipalities with low ratio (red) are mainly found in rural areas along the Apennines, in Sardinia and the Sicilian inner-land, while municipalities with a high ratio (darker blue), are usually found closer to the shoreline and touristic areas.

[31]The Appendix D provides further information on this.

$$CV_i = 59.51 + 0.172 MV_i. \tag{14}$$

These conclusions are in line with the literature on property assessments (McMillen and Singh, 2020), and the one on the Italian property tax system. Cammeraat and Crivelli (2020) also document the decrease in the assessment ratio as the market value of a house increases and, using a microsimulation, show that switching the property tax base from cadastral to market values reduces the regressivity of the tax. Namely, the incidence of property taxes on incomes reduces for households in the lowest deciles, while it increases for households in higher deciles.

Figure A4: Market to Cadastral Value Ratio Across Municipalities



Notes: The figure shows the market to cadastral value ratio across municipalities. The data is obtained through the combination of different sources of data provided by the Italian Tax Agency. Appendix D provides further information on sources and elaboration.

B Information on Data Used

This appendix provides a description of the data used for the statistics on homeownership throughout the paper. Furthermore, it provides additional information on the homeownership setting in Italy.

SHIW

The Survey on Household Income and Wealth (SHIW) is a survey that started from 1965 with the aim of collecting data on the demographic and socio-economic characteristics of Italian households. From 1987, the survey is conducted every other year, except for a three year gap between 1995 and 1998. The survey unit is the household, that is characterized by the group of people that live in the same dwelling and that are related by either blood, marriage or adoption. The survey has information on the household components, their education, the occupational history of the household's adults, and information on household incomes, wealth and housing conditions. I reduce the household to the reference person who is defined as the person responsible for the household budget. All prices have been converted in 2016 euro using the deflators provided by the survey or by the OECD. The sample size for each wave is of approximately 8000 households. I use the SHIW in three circumstances: computing statistics on homeownership for 2016, computing statistics on transfers for 2002, and calibrating two parameters for the period 1995-2016.

Statistics for 2016

Homeowners are defined as households that live in a dwelling that they own. I do not classify as homeowners households that live in a dwelling for which they have right of redemption. Households own a dwelling if they own 25% or more of it. Wealth is defined as the addition of real assets and financial assets, minus any financial liability. The separation on quintiles (wealth and income) is done according to the variable provided in the survey. All statistics are obtained by weighting observations according to the weights given in the survey.

For Table A1: households are classified as having any real estate if they have a positive amount. Household are classified as having mainly real estate if the real estate value is larger than the combination of financial assets and real assets excluding real estate. Households are classified as having only real estate if the real estate value is positive and the value of securities plus business assets is 0. The value of real estate is the mean among households that own real estate. A household is classified as having an outstanding mortgage if they have any outstanding loans from banks, financial companies or other institutions for the purchase or renovation of your principal residence.

For Table 2: Average wealth and homeownership are computed as weighted averages of age-group average wealth and homeownership. The weights are given by the relative size of the population according to the model. Statistics on the distributions for retirees are computed on net wealth, i.e. the maximum between the wealth and 0.

For Table A2 and Figure 5: The value of the main residence has been adjusted to incorporate the percentage of ownership of the household for that property.

Statistics for 1995-2016

The SHIW provides information on consumption and rent, which I used to obtain the consumption share. I used data on households that pay rent and homeowners that obtain rent. Furthermore, I have used information on real estate value that households own to obtain the 10th and 90th percentile of the distribution of house values needed for the calibration.

Statistics for 2002

Whereas each survey wave contains information on the mode of acquisition of the properties that household own, such as purchased it or inherited it, only the 1991 and 2002 waves contain a special module with information on all types of bequests and gifts obtained throughout the life-time (Cannari and D'Alessio, 2008). Following Cannari and D'Alessio (2008) the bequest data has been merged to the property data. This has been done to account for the fact that some households claimed not to have had transfers in the special module, yet stated that they inherited the property they owned. Values of transfers have been deflated to 2016 euro using the OECD CPI deflators.

For Figure A1 and A2: I restrict the sample to households with the head between 25 and 44 years old. I separate these households according to wealth and income decile. Then I create three wealth and income groups as described in the main text.

EU-SILC

European Union Statistics on Income and Living Conditions (EU-SILC) is a survey that started from 2004 with the aim of collecting in a standardized manner information on demographic and socio-economic characteristics, and income of several EU countries. It is conducted every year and it has a rotational design that creates both a cross-country survey and a panel survey. The panel dimension lasts four years. I use panel waves between 2007 and 2012 only for Italy to estimate income processes and tax functions. The Italian sample size for the longitudinal 2012 wave is around 5500 households.

EU-SILC provides information on total gross and net household income which has been used to estimate the tax function. This total income includes labour income, benefits or losses from self-employment, pensions, social security benefits, and income from capital or rents. Instead, to estimate the income processes I have used information on just labour income.

C Details Property Taxes in Italy

This appendix provides clarifications on property taxes in Italy. I focus on the tax system between the years 2012 and 2018. The taxation of properties falls onto different taxes: income based taxes, wealth based taxes, transfer based taxes (Dipartimento delle Finanze, 2020). The analysis I have performed in the text focuses on only the wealth taxation part, and more specifically the Single Municipal Tax (*Imposta Municipale Unica, IMU*), leaving aside the Tax for Indivisible Services (*Tributo per i Servizi Indivisibili, TASI*). These two taxes have been integrated in the Unique Municipal Tax (*Imposta Unica Comunale, IUC*) from 2014. As it can be see from Table C1, that shows the revenue from the different property taxes, the IMU is the largest component. Furthermore, notice that Figure A3, which uses data from the OECD National Accounts database Table 10 (Taxes and social contributions receipts; Taxes on land, buildings, and other structures), displays information only on the wealth based taxes, and not on other sources.

Table C1: Government Revenue by Tax Source. Billions of Euros

Tax Type	2012	2013	2014	2015	2016	2017	2018
1. Income base taxes	7.79	8.74	8.19	8.26	8.52	8.52	8.56
2. Wealth base taxes	24.67	20.56	25.07	25.11	20.57	20.41	19.81
IMU	24.67	20.56	20.32	20.33	19.43	19.29	18.72
Owner Occupied	4.07	0.47	0.09	0.1	0.08	0.08	0.07
Other	20.6	20.1	20.23	20.23	19.35	19.22	18.65
TASI			4.74	4.78	1.14	1.12	01.08
Owner Occupied			3.5	3.56	0.02	0.02	0.01
Other			1.24	1.22	1.11	1.1	01.07
3. Transfer base taxes	10.84	9.65	9.6	10.15	10.78	12.16	12.26
Total (1 + 2 + 3)	43.3	38.95	42.86	43.52	39.87	41.09	40.63

Notes: The table shows the government revenue from taxation of properties, split by the nature of the tax base. Source: Dipartimento delle Finanze (2020)

The IMU has been operational since 2012, and from its origin, the tax treated differently owner-occupied houses from other properties. The base property tax rate applied to owner-occupied houses, with the exceptions of luxury properties, was of 0.4%, while the one for all other properties of 0.76%. These base property tax rates could be altered by municipalities within a range: 0.2% to 0.6% for the owner-occupied house, and 0.46% to 1.06% for other properties. Nonetheless, this distinction became superfluous from 2013, as owner-occupied houses were exempt from the IMU.

The TASI has been operational since 2014, and up to 2015 it applied to all properties. The base tax rate for the TASI was of 0.01%. Also in this case municipalities could alter the base rate. It is important to note that whereas the base rate for the TASI was lower than the one for IMU, the TASI had much lower deductions. Because of this, the revenues collected from owner-occupied houses with the TASI between 2014 and 2015 were of similar magnitude than then revenues collected with the IMU in 2012 (Messina and Savegnago, 2015). It is for this reason that in the text I claim that the owner-occupied exemption was reinstated from 2016.

Table C2 provides information on the tax rate for IMU and TASI, and the deductions applied across the municipalities in Italy. The data has been provided by the Institute for the local finances and economies *Istituto per la Finanza e l'Economia Locale, IFEL*). I have excluded from the sample the municipalities with full deductions for IMU or TASI, 22 and 4 respectively out of approximately 7700. The first two rows show the unweighted statistics for 2012 of the IMU tax rate and deductions for the owner-occupied dwelling. The third row shows the IMU tax rate for other properties for the 2012-2018 period. The fourth and fifth rows show the unweighted statistics for 2014-2015 of the TASI tax rate and deductions for the owner-occupied dwelling. The last row shows the TASI tax rate for other properties for the 2014-2018 time period.

As stated in the main text, tax rates apply on the cadastral value of a property. The cadastral value is obtained by multiplying the *cadastral rent* of a property by the *coefficient of revaluation* and a *cadastral multiplier*. The *cadastral rent* is a measure associated with the theoretical income that can be obtained from a property. This depends on the characteristics of the dwelling (location, size, floor) or the land. The calculations to obtain this theoretical income have not been updated from the late 80s. The *coefficient of revaluation* is an arbitrary multiplier that has been implemented from 1997. This multiplier is the same for all properties. It takes a value of 1.05 for dwellings and of 1.25 for agricultural land.

Table C2: Municipal Tax Rates and Deductions for IMU and TASI.

	Mean	SD	Min	P25	P50	P75	Max
IMU Tax Rate - O.O.	4.27	0.77	0	4	4	5	6
IMU Deductions - O.O.	200.99	30.17	200	200	200	200	2500
IMU Tax Rate - Other	8.85	1.16	4.6	7.6	8.6	9.7	10.6
TASI Tax Rate - O.O.	1.65	0.91 0	1	2	3	3	3.3
TASI Deductions - O.O.	6.99	30.97	0	0	0	0	1000
TASI Tax Rate - Other	0.72	0.77	0	0	1	1	3.3

Notes: The table shows the tax rate and deductions for IMU and TASI. Tax Rates (rows 1,3,4,6) are in per thousand. Deductions (2 and 5) are in current euros. All statistics are unweighted. Time period is 2012 for the first two rows, 2012-2018 for row 3, 2014-2015 for rows 4-5, and 2014-2018 for row 6. Own elaboration with data from IFEL.

Finally, the *cadastral multipliers* depends on the cadastral type (i.e. residences, offices, shops and so on and so forth) and use of the property. The idea behind the cadastral multiplier is to convert the measure of income derived from the property (the *cadastral rent*) to a measure of the value of a property. Hence, the cadastral multiplier can be thought of as the inverse of a capitalization rate (Guerrieri, 2013). The 2012 reform increased the cadastral multipliers for several cadastral types, increasing the value of the properties for the tax agency. All properties within the same cadastral type experienced the same increase. As shown in Table C3, for main residences, the type I focus on for the analysis, the multiplier increased from 100 to 160. This means that the value of a dwelling for the tax agency increased by 60%. In other words, the effective tax rate increased by 60%.

As stated in the main text, the model's prediction on tax revenue does not reflect the data from Figure A3. The reason for this divergence is the fact that the data shows total revenue collection from ownership of land, buildings, and other structures by any kind of legal entity. Meanwhile, the model shows tax revenue collected from people, focusing on main houses and rented houses. In order to obtain a comparable measure of tax revenue collection from the data, I starts from cadastral information and perform a series a series of calculations described below.

Table C4 shows the cadastral rents by type and use of dwelling for 2016. Firstly, it is possible to see that the total value of cadastral rents of residences (16.89 billion) is

Table C3: Changes to the Cadastral Multipliers of the 2012 Reform

Cadastral Type	Pre 2012	Post 2012
Residences and residential appliances	100	160
Schools, public offices and buildings	140	140
Shops	34	55
Offices	50	60
Warehouses and sport facilities	100	140
Banks' offices	50	80
Luxury residences	50	80
Agricultural lands	75	110

Notes: The table shows cadastral multipliers pre- and post-2012 reform.

less than half of the total value of overall cadastral rent (36.80 billion). Secondly, the total value of cadastral rents of legal persons (real estate firms in the model) is similar to the total value of rented residences by natural persons. Thirdly, among the total value of cadastral rents of residences of natural persons (15.57 billion), the main residences makes up the majority of the value. The second largest component is Other, which is made up of secondary or empty houses, and is not included in the model. Rented makes up the smallest part of the value.

From this data one can obtain an approximate measure of property tax revenue in two steps. First, calculate the total cadastral value of rented residences by multiplying the cadastral rents of rented residences (1.56 billion) by 1.05 and 160, the multiplier. Second, apply to this value the national property tax rate (0.76%). We obtain that property tax revenue are approximately 0.12% of the 2016 GDP. The model underestimates the property tax revenues as % of GDP obtained in this manner (0.06%), yet the estimates are comparable. By applying similar calculations to the cadastral rent for main residences, we obtain that by removing the owner-occupied exemption the tax revenue should increase by approximately 14 billion euros.

Table C4: Cadastral Rents by Type and Use

Use/Type	Residences	Other types	Total
Natural persons	15.57	7.01	22.57
Main residences	10.77	0.00	10.77
Rented	1.56	2.62	4.17
Other uses (secondary, empty)	3.24	4.39	7.63
Legal persons	1.33	12.90	14.23
Total	16.89	19.91	36.80

Notes: The table shows the cadastral rents in billions of euros by type and use across Italy for 2016. Data retrieved from Dipartimento delle Finanze (2020).

D Information on Cadastral Values and Market Values

This appendix provides information on the data used to estimate the relationship between cadastral value and market value at the municipal level. Additionally, I provide further remarks on the difference between the two.

To estimate the average house market price at the municipal level I use the Quotation Database of the Real Estate Market Observatory (*Banca Dati Quotazioni dell'Osservatorio del Mercato Immobiliare*). This dataset must be requested from the Italian Tax Agency. The dataset contains information on minimum and maximum estimated market prices per square meter within micro-areas called *Zone OMI.* This micro-areas are a key aspect of the dataset: if too large, they cannot provide a great deal of information, if too little they cannot be estimated.

The agency created the micro-areas as a continuous portion of the municipal territory that are in the same local housing market, and present uniform economic and socio-environmental conditions. For each micro-area, and for several dwelling type, the agency estimates the minimum and maximum market price for every semester by using transaction data and modelling techniques.

I use the market price estimates for the first and second semester of 2016. I only use estimates for civil houses, as this is the focus of the main analysis, that have been classified as having been maintained *Normally.* I them obtain the mean price per micro-area per semester as the simple average between the minimum and maximum price reported. I obtain the average price per square meter per micro-area for 2016 as the mean of the prices for first and second semester. Finally, I obtain the price per square meter at municipal level by averaging the price across all the micro-areas within a municipality. I compute a weighted average, with the weight given by the area of each micro-area. The tax agency provides both the information on the area of the micro-areas, and on the municipality they belong to.

As the estimates prices are computed in terms of square meters, I had to multiply these estimates by a measure of the average square meters. I used information at the provincial level of total numbers of civil houses (cadastral type A2) present and total estimated amount of area covered by these. Hence, I assume that each municipality within a province has the same average square meters. This data is publicly available and can be obtained from the adjoined tables of the tax agency urban cadastral statistics report for 2016.

Finally, I obtained the average cadastral rents at the municipal level for private houses in 2016 by requesting this information from the Tax Agency. Also in this case I focused on civil houses (cadastral type A2). I multiplied the cadastral rents by 160 (the cadastral multiplier) and by 1.05 (the revaluation coefficient) to obtain the cadastral value. Thus, I calculate the ratio $(\frac{MarketValue_i}{CadastralValue_i})$ for each municipality i. There are several other possible measures that can be used to account for the difference between the two values (refer to Festa and Erika, 2014, Curto et al., 2021). It is important to remark that simple difference between the two, $D_i = MV_i - CV_i$, is not ideal for the comparison across housing values. Two municipalities could have the same value for the difference but completely different market and cadastral values. For instance, $D_1 = 100.000 - 50.000 = 50.000 = 500.000 - 450.000 = D_2$. For the second municipality the cadastral value is a good proxy of market values, while for the first one it is not.

Table D1 shows the unweighted statistics for the market value, the cadastral value and the ratio across municipalities. Notice that the average ratio is less than the one calculated by the Ministry of Economy and Finance of approximately 2. This is because this is an unweighted average across municipalities, not across houses.

Table D1: Municipal Level Statistics on Market Value, Cadastral Value and Ratio

	Market Value	Cadastral Value	Ratio
Mean	120490	80542	1.56
SD	58317	26271	0.69
Min	18353	5975	0.20
P25	86174	64353	1.12
P50	108446	77864	1.44
P75	140608	92965	1.85
Max	1010462	701541	12.73

Notes: The table shows unweighted statistics of the Market Value, Cadastral Value and the Ratio across municipalities for 2016. Municipalities with a market value of 0 have been excluded.

As discussed in the main text, a higher ratio is found in locations that experiences a higher price growth in the past 30 years. The literature has focused on showing the inequality of the ratio between touristic and non-touristic municipalities (Longhi, 2015). In Table D2 I show, using a regression with the ratio as dependent variable, that I obtain a similar result with my data: touristic locations (that have the Tourist Dummy equal to 1) tend to have a higher ratio. Furthermore, I show that the average income of a municipality is also positively related to the Ratio. I defined a municipality to be touristic if the Italian Statistical Agency (ISTAT) classified it as being in the fourth and fifth quintile of their touristic municipality index for 2019. I obtained on average income from ISTAT as taxable income per contributor for 2016.

The difference and relationship between cadastral value and market value is important for the anlaysis I conduct for two reasons. First, to determine the effective property tax rate for a given market value (Equation 12). Second, to show that the property tax system is regressive. Regarding the former, Table D3 shows the regression of cadastral value on market value. I present several specification that differ in the sample size and in the use of fixed effects. I use the third specification to estimate the effective property tax rate, yet no qualitative change would occur by selecting another one.

Regarding the regressivity of the property tax system, notice that all specifications

Table D2: Municipal Level Statistics on Market Value, Cadastral Value and Ratio

	(1)	(2)	(3)	(4)	(5)
Ln Income	0.441***		0.169***	0.376***	0.0748
	(0.000)		(0.000)	(0.000)	(0.222)
Tourist Dummy		0.384***	0.372***	0.258***	0.309***
		(0.000)	(0.000)	(0.000)	(0.000)
Ln Pop			0.0386***	0.0199***	0.0290***
			(0.000)	(0.006)	(0.000)
Ln Area			-0.0539***	-0.0284***	-0.0341***
			(0.000)	(0.005)	(0.001)
Constant	-2.742***	1.426***	-0.354	-2.197***	0.234
	(0.000)	(0.000)	(0.308)	(0.000)	(0.678)
Observations	7333	7331	7331	7331	7331
R^2	0.022	0.078	0.096	0.465	0.220
Province FE	No	No	No	Yes	No
Region FE	No	No	No	No	Yes

Notes: The table shows the regression at municipal level of the ratio on independent variables. The fourth and fifth column are estimated using Province and Region Fixed Effects, respectively. The p-values in parentheses. Robust S.E. used. * p<0.10, ** p<0.05, *** p<0.01.

of Table D3 point to a regressive system: a constant significantly different than 0 and the coefficient on the market value variable significantly positive. These estimates imply a system that features inequity and regressivity as market values increase faster than cadastral value, meaning that expensive houses have a relatively lower cadastral value Festa and Erika (2014). Table D4 shows other analysis that have been suggested by the literature to identify inequity and regressivity of a property tax system (Paglin and Fogarty, 1972, Kochin and Parks, 1982, Bell, 1984). All of them show signs of regressivity.

As stated in Appendix C, in the main analysis I focused on the wealth based property tax, disregarding the income and transfer taxes related to properties. It must be noted that also (some of) these latter taxes use the cadastral value rather than the market value. Instances of these are taxes related to: inheritance and gifts, acquisition and selling, and in some cases a part of rental income.[32]

[32] Refer to the article by Bortolamai 2022 titled *Quali imposte dipendono da valori e rendite catastali e che gettito danno?*

Table D3: Regression of Cadastral Value on Market Value

	(1)	(2)	(3)	(4)	(5)
Market Value	0.215***	0.204***	0.172***	0.150***	0.166***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	54695.7***	55962.1***	59512.3***	57747.7***	60963.2***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	7366	7341	7098	7098	7098
R^2	0.229	0.189	0.132	0.513	0.228
Province FE	No	No	No	Yes	No
Region FE	No	No	No	No	Yes

Notes: The table shows the estimated coefficients of the regression of cadastral value on market value. I present 5 specifications: The first column uses all the range of market and cadastral value, the second limits both the market and cadastral to 500.000 euros. The third to the fifth column limit sample of the market and cadastral value between the first and ninety-ninth percentile. The fourth and fifth column are estimated using Province and Region Fixed Effects, respectively. The p-values in parentheses. Robust S.E. used. * p<0.10, ** p<0.05, *** p<0.01.

Table D4: Regression of Cadastral Value on Market Value

	(1) Cad. Val.	(2) Ratio	(3) Assessment Ratio	(4) Ln. Cad. Value	(5) Ln. Mark. Value
Market Value	0.188***	0.00000911***			
	(0.000)	(0.000)			
Square Market Value	-5.39e-08				
	(0.513)				
Ln Market Value			-0.582***	0.248***	
			(0.000)	(0.000)	
Ln Cadastral Value					0.444***
					(0.000)
Constant	58503.9***	0.463***	7.512***	8.374***	6.614***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	7098	7098	7098	7098	7098
R^2	0.132	0.482	0.494	0.110	0.110

Notes: The table shows the several regressions to understand the inequity and regrssivity of a property tax system. The p-values in parentheses. Robust S.E. used. * p<0.10, ** p<0.05, *** p<0.01.